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Perennial vegetation, human adaptation, and resilience in the U.S. Corn Belt social-ecological system

Ryan Cardiff Atwell
Iowa State University

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“Very truly, I tell you, unless a grain of wheat falls into the earth and dies, it remains just a single grain; but if it dies, it bears much fruit.”—John 12:24 (NRSV)

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ABSTRACT

Emerging biofuel markets in the U.S. Corn Belt are leading to increased production of rowcrops and removal of land from conservation programs. This comes at a time when regional research highlights the importance of perennial cover on key areas of the landscape to promote the continued delivery of societal goods and ecosystem services from agricultural lands. The goal of this research is to analyze how the restoration of perennial vegetation interplays with social and ecological contexts at multiple scales to impact the resilience of communities and landscapes in the rural Corn Belt. I addressed this goal through a series of 33 in-depth interviews with farmers and other rural stakeholders living near Stanhope, Iowa and through a participatory scenario development workshop with regional leaders in Iowa agriculture, conservation, and policy. Qualitative analysis of interview and workshop data was integrated with the results of other social and ecological research and interpreted through the lens of resilience theory. I found that farmers and rural residents perceived their “countryside” primarily in social terms, identifying strongly with the farming lifestyle and with networks of people across the landscape. While most interviewees approved of landscape-scale restoration practices on marginal agricultural land, implementation of these practices was not a priority in rural culture and rural people voiced little understanding of, or sense of control over, regional institutions. Interview data indicate that future adoption of conservation practices will be based not simply on immediate profitability, but upon a convergence of contextual factors at three key levels: 1) compatibility with infield farm practices, 2) community-level reinforcement through social networks and norms, and 3) consistent, straightforward policies and institutions. Regional leaders also voiced enthusiasm about the potential for perennial conservation initiatives to achieve multi-objective societal benefits including enhanced biodiversity, soil and water quality, farm profitability, and rural vitality. These leaders suggested that the success of such initiatives will be dependent upon building policy mechanisms that integrate working lands and protected areas and link local creativity and initiative with regional vision, support, and accountability. In all instances, strategic collaboration between diverse partners who operate at different levels in the system will be needed to mediate the macro-level, top-down effects of technology, markets, and policy on farmer land-use decisions.
CHAPTER 1: GENERAL INTRODUCTION

Change is both a disruptive and renewing force in natural and human systems (Gunderson and Holling 2002, Walker et al. 2006). When change is driven by collective human decision making, its ramifications can be very difficult to predict because many plausible courses of action may be chosen. In natural resource management, the dynamic decisions of social actors often heighten the difficulty involved in addressing what are already complex ecological questions.

This is the case in agroecosystems of the north-central U.S. Corn Belt, a landscape with a long history of change driven by the interplay of natural processes and the decisions of its human inhabitants (Axelrod 1985). This region is currently undergoing a period of rapid and uncertain reorganization driven by an increased demand for bioenergy crops (Hinkamp et al. 2007). A recent spike in the demand for corn-based ethanol is currently leading to more land in rowcrops and less land in perennial cover types (Secchi et al. 2008). This change in land use comes at a time when regional loss of perennial cover is increasingly implicated in declining biodiversity, water quality, flood control, and other ecosystem services (Best et al. 1995, Schulte et al. 2006, Hatfield et al. 2008). In particular, the export of agricultural nutrients (nitrogen and phosphorous) from Corn Belt river systems is implicated as a key driver of downstream hypoxia in the Gulf of Mexico (EPA Science Advisory Board 2007). Corn Belt stakeholders are concerned with how changes in agriculture associated with bioenergy production will impact the environment, natural resources, and long term sustainability of the region’s rural landscapes (Hinkamp et al. 2007).

System re-organization associated with emerging bioenergy markets, technologies, and crops will change the landscape in unexpected ways, presenting new challenges and opportunities for conservation. For example, initial research indicates that conservation strategies that integrate small, carefully-targeted patches of perennial cover within Corn Belt agricultural landscapes (e.g., constructed wetlands, stream buffers, pasture, diverse cropping rotations, and certain biomass crops) can disproportionately benefit regionally-impaired ecosystem services (Schulte et al. 2006, Nassauer et al. 2007b, Schulte et al. 2008). Although there is growing evidence for the benefits of restoration of perennial vegetation in
agroecosystems, such practices have yet to be widely embraced by rural residents, adopted by farmers, or integrated into Farm Bill legislation.

Resilience theory is an emerging approach for understanding and influencing processes of change in complex natural resource management systems (Gunderson and Holling 2002, Folke et al. 2004, Walker et al. 2006). This framework has received widespread attention and application among scientists and practitioners from diverse fields (Carpenter and Folke 2006, Liu et al. 2007), but has seen little use in the study of regions dominated by intensive agricultural production and autonomous private property rights (Allison and Hobbs 2004, 2006). The term “resilience” was applied to ecological systems by Holling (1973) and refers to the ability of dynamic systems to respond to perturbations and maintain their essential configuration. Resilience is a non-normative term; system configurations characterized as resilient may be either desirable or undesirable. In particular, resilience theorists are interested in understanding where resilience, adaptive capacity, and the potential for innovation reside in linked social-ecological systems and how these attributes can be gained, lost, or preserved. Because human values, perspectives, and collective decisions are fundamental in determining the structure, function, and desirability of social-ecological systems, resilience analyses emphasize the integration of stakeholders and policy makers in scientific and decision making processes (Walker et al. 2002).

The goal of my dissertation research was to determine how restoration of perennial vegetation interplays with social and ecological contexts at multiple scales to impact the resilience of communities and landscapes in the rural Corn Belt. I addressed this goal through a series of 33 in-depth interviews with farmers and other rural stakeholders and through a participatory workshop with regional leaders in agriculture, conservation, and policy. Qualitative analysis of interview and workshop data was integrated with the results of other social and ecological research and interpreted through the lens of resilience theory. Qualitative analysis is a tool that has been rigorously developed in the social sciences and is particularly useful in investigating questions with a depth and breadth that is not often afforded by quantitative approaches (Huberman and Miles 2002).
**Thesis Organization**

My dissertation is comprised of a general introductory chapter, four chapters targeted for publication in scientific journals, and a chapter summarizing the conclusions and management implications of my research. Chapter 1 contains a general introduction and brief overview of my research. Chapter 2 examines how farmers and rural stakeholders perceive and value the social and ecological aspects of the landscapes in which they live. Chapter 3 describes farmers’ perspectives on how adoption of perennial conservation practices in Corn Belt landscapes are constrained or enhanced by social and ecological factors at multiple scales. Chapter 4 analyzes the insights of regional leaders for developing strategies to promote perennial vegetation and bolster regional adaptive capacity. Chapter 5 incorporates the insights of regional leaders with the results of other regional ecological and social research for developing future policy scenarios which could drive Corn Belt land use. Chapter 6 summarizes the findings and management implication of my research.

Research design, data collection, analysis, and the preparation of this manuscript were the responsibility of the candidate; Dr. Lisa A. Schulte provided guidance and editorial feedback on all aspects of this research. In addition, Lynne Westphal, one of my dissertation committee members and a research social scientist and project leader with the US Forest Service, provided a combination of project guidance, assistance with data analysis, and editorial advice. They both appear as co-authors on all chapters that will be submitted to scientific journals.
Literature Cited


CHAPTER 2.
LANDSCAPE, COMMUNITY, AND COUNTRYSIDE:
LINKING BIOPHYSICAL AND SOCIAL SCALES IN U.S. CORN BELT
CONSERVATION INITIATIVES

A manuscript submitted to *Landscape Ecology*

Ryan Atwell, Lisa Schulte, and Lynne Westphal

**Abstract**

Understanding the interplay between ecological and social factors across multiple scales is integral to ecological restoration initiatives in working landscapes such as the rural U.S. Corn Belt. In this study, we investigated the socio-cultural context surrounding the use of perennial cover types—such as stream buffers, wetlands, and diverse cropping rotations—to restore water quality, biodiversity, and ecosystem function within a Corn Belt agricultural mosaic in Iowa, USA. Through ethnographic techniques and 33 in-depth interviews we examined how farmers and other rural residents perceive their landscape. Photo elicitation was also used to probe interviewees’ assessments of conservation practices involving perennial cover types. The majority of our interviewees related to the rural “countryside” primarily in social terms, identifying strongly with the farming lifestyle and with networks of people across the landscape. They expressed deep concern about declines in the number of rural people, farm families, and community resources that have accompanied agricultural intensification. While most interviewees approved of landscape-scale restoration practices on marginal agricultural land, implementation of these practices was neither a priority nor strongly assimilated into rural experience and ethics. Although interviewees viewed their landscape as an integrated social and biophysical entity, we identified three key scalar mismatches inherent in rural perceptions of place which must be bridged if rural ecological and social problems are to be effectively addressed. In all cases, community social norms and networks—exhibited at landscape spatial scales—may be instrumental in spanning these gaps.
Introduction

Upwards of 95% of the land in the north central U.S. Corn Belt is privately owned, and nearly 80% of this landscape is devoted to high input, row crop agriculture (USDANASS 2002). Recent studies show that the increasing nitrate levels in the region’s rivers which contribute to hypoxia in the Gulf of Mexico (Rabalais et al. 2002) are best explained by a decrease in the amount of perennial crops and pasture in agricultural watersheds over the last several decades (Hatfield et al. 2008). Three states in the Corn Belt Region—Indiana, Illinois, and Iowa—rank lowest in the U.S. in the amount of remaining natural vegetation (Klopatek et al. 1979).

As the Corn Belt enters a time of fast-paced and uncertain change driven by the emerging demands of the bioeconomy (Hinkamp et al. 2007), new challenges and opportunities in land use present themselves (Gunderson and Holling 2002). Initial research suggests that strategic restoration of perennial land cover in the form of crop rotations and pastures, well-managed multi-species riparian buffers and wetlands, and concentrated areas of remnant and restored forest and prairie (hereafter collectively referred to as “perennial conservation practices”) need comprise only a small portion of the landscape in the Corn Belt region in order to realize marked gains in water quality and biodiversity (Moshiri 1993, Best et al. 1995, Schultz et al. 2004, Schulte et al. 2006). Some studies suggest that increases in perennial conservation practices may also be socially and economically beneficial (Jackson and Jackson 2002, Santelmann et al. 2004, Boody et al. 2005, Nassauer et al. 2007b).

Although landscape-scale perennial conservation practices show promise in bolstering the resilience of regional ecological systems, it is currently unclear how such practices are perceived by rural people. Research and theory in the environmental social sciences show that conservation behavior is not based primarily on rational or economic decision making, but rather on a complex interaction of values, attitudes, and norms that are in turn shaped by an individual’s biophysical, social, and cultural context (Cheng et al. 2003, Ajzen 2005, Clayton and Brook 2005). This generalization is born out by substantial research on rural attitudes and decision-making surrounding conservation and the environment in the Corn Belt (Nassauer 1995, Stein et al. 1999, Corselius et al. 2003, Morton and Padgitt 2005, Urban 2005).
Increasing the diversity and amount of perennial cover on the landscape presents a markedly different agricultural conservation strategy than what has been practiced in the Corn Belt for the last several decades (Schulte et al. 2006, Nassauer and Kling 2007). Current trends in land use are towards increased corn monoculture in response to demand from new ethanol plants coming online (USDA NASS 2007). Proponents of the dominant trend towards agricultural intensification point to current set-aside programs, improvements in soil stewardship, and field-based management innovations (e.g., minimum-till, no-till, and precision application of nutrients) as evidence that major alterations in the landscape are unnecessary to balance agricultural production with environmental goals (Peters et al. 1999, Wilson 2001). Policy makers and farmers are often resistant to increases in farm diversification or landscape heterogeneity, seeing such changes as expensive and counter-productive throwbacks to the past (Peters et al. 1999, Urban 2005). In addition, farm diversification and landscape heterogeneity may conflict with the cultural norms of what a successful, well-operated farm looks like (Nassauer 1995, Urban 2005).

Our research is grounded in the premise that, if perennial conservation practices are to be adopted at a landscape scale in the Corn Belt, we must understand how they are linked with other components of the socio-cultural system and consider the scales at which these components are operating. Hierarchy theory in ecology emphasizes that function and process at any one scale of a system must be understood in relation to function and process at the scales immediately above and below the one in question (Allen and Starr 1982). Several models from the environmental social sciences show that synergies or mismatches across scales may also help explain why stakeholders do, or do not, embrace seemingly beneficial conservation practices (Norton and Hannon 1997, Westley et al. 2002, Flora 2004, Morton In Press). These models also suggest that community-level social norms play a key role in mediating top-down influences on decision making—such as economic markets and government regulations/incentives—and the values and beliefs of individuals and households.

Because of the recognized importance of social norms in mediating conservation behavior, we examined how rural people experience and value their landscape within the
context of one rural Corn Belt community. Through our work in this community we addressed the following study questions:

a) What are the important contextual factors that influence how farmers and rural residents experience and value their landscape at different biophysical and social scales?

b) Are there inter- and intra-scale synergies and mismatches inherent in the ways that these people experience and value their landscape?

c) How do these synergies and mismatches promote or hinder regional resilience and landscape-scale conservation practices?

Methods

Study Area

Hamilton County lies on the Des Moines Lobe (Omernik et al. 1993; Fig. 2.1), an eco-region in north central Iowa and south central Minnesota identified as contributing disproportionately to Gulf of Mexico hypoxia (Rabalais et al. 2002). Due to the flat macro-topography and extensive subsurface drainage of agricultural land on the Des Moines Lobe, this area sees relatively less surface erosion and Conservation Reserve Program (CRP) enrollment, but more tillable hectares and subsurface nitrate leaching when compared with other geologic formations in the Corn Belt (Anderson 2001). Hamilton County in particular, and the Des Moines Lobe in general, exemplify the state of Iowa and the Corn Belt in high preponderance of row crop agriculture, high levels of concentrated animal production, consolidation of agriculture into large farms, loss of farmers from the land, and their increase in non-farm rural residents (Table 2.1).

We initially bounded our study site to the 39,330 ha headwaters of the Squaw Creek watershed that lie in Hamilton County (Fig. 2.1). Previous research throughout this entire watershed by Wagner and Gobster (2007) documented uncertainty in residents’ understanding of the definitions, causes, consequences, and current state of local water and stream quality. As we began to work in the upper portion of the Squaw Creek watershed, it quickly became apparent that the municipal and ecological boundaries that defined our study site did not mesh with the ways in which our subjects experienced their landscape. Many
watershed residents farmed and had close family and community ties across an expanse of countryside that also encompassed the headwaters of two other small watersheds, the Boone and the South Skunk, and four small towns. To remain consistent with our research objectives, we expanded our study area to include this “peopleshed,” an area which roughly coincides with the western two-thirds of the rural 52,577 ha South Hamilton School District (Fig. 2.1). All three of the watersheds within our study area are currently targeted by research and management initiatives to better understand and influence the interplay between agricultural intensification and ecosystem services.

**Data Collection**

We used an ethnographic approach to gain entrance into our study site (Neuman 2003). This included initiating informal conversations with local residents about our research through visits to local coffee spots, churches, and other gathering places. Based on insight gained from these discussions, we used snowball sampling (Neuman 2003) to seek out participants for in-depth interviews who represented a diversity of local perspectives within the following overlapping groups: farm operators, farm owners, non-farm rural residents, rural opinion leaders, and local conservation personnel. Among these groups, we prioritized interviewing civically active farmers whose behavior, decisions, and influence were recognized by other community members as impacting sizable portions of the landscape (>200 ha). Only three of the people we contacted refused to be interviewed. We continued to initiate interviews until we reached “saturation” in relationship to major study questions—the point at which we begin to be able to predict subject responses based on previous interviews and analyses (Neuman 2003).

Interviews followed an open-ended guide—while similar questions were asked and similar topics were covered in each interview, the exact wording and flow of questions varied between interviews. Interviews included three sections. The first section began with the broad question, “What is most important to you about the rural countryside?” We probed how interviewees perceived the natural landscape, how they viewed their neighbors and community, what challenges they saw facing their rural area, and what local assets and amenities they most valued. In the second section, we used 14 pictures of Corn Belt
agricultural landscapes to elicit participants’ evaluations of different land uses and cover types (Harper 2002). Photos were selected to represent a suite of potential landscape scenarios that varied from maximization of row crop production on one end of the spectrum to high concentration of perennial conservation practices on the other. Each interview closed by reviewing our conversation and by asking how each interviewee would envision landscapes of the future.

**Qualitative Data Analysis**

All interviews were recorded and transcribed. Text transcriptions were imported into the NVivo7 data management and analysis software package (QSR 2006). Interview data were coded in NVivo7 into descriptive and topical categories by the lead author. These codes were used to further analyze which themes in the data were strong or weak, how themes were related to one another and to study questions, and how the data reinforced themes and with what caveats. When evaluating the strength, or emphasis, with which different interviewees voiced different themes, we counted how often a theme was revisited during discussion, but we also looked closely for the use of strong language and emotion, especially in key transitions, metaphors, and stories within interviews. Validity in qualitative research is based on probing the plausibility, accumulation, and connectedness of themes as they emerge through iterative analysis of empirical data (Neuman 2003). To ensure that analysis was consistent, valid, and confirmable, the second and third authors each read a non-overlapping and randomly assigned one-third of all interviews. Together, all authors compared coding choices and worked to develop consensus on the meaning and identifying features of themes in the text. After consensus was reached, transcripts were re-read and re-coded to more closely analyze the agreed upon themes.

**Results**

**Interviewee Characteristics**

We conducted 33 in-depth interviews with 42 participants; several interviews were conducted with pairs, usually husband-wife couples. Interviews generally took place in participants’ homes, and lasted an average of 74 minutes. Of the 42 people we interviewed,
11 were women and 31 were men; 14 were non-farm rural residents and 28 were farm operators. Five of these farmers had retired. Twenty-six of our interviewees owned farmland. Most of the non-farm rural residents we interviewed worked within our study area; four commuted between 20 km to 120 km to their places of employment. Thirty-seven of the people we interviewed were raised in rural areas, and 31 grew up within 20 km of our study site. Our interviewees were active in formal and informal civic organizations such as coffee groups, churches, farm and service organizations, fraternal societies, and municipal boards.

The 23 active farmers we interviewed ranged in age from 23 to 64 years old, and averaged 51 years old. Nineteen of these farmers received 50% or more of their household income from farming. Farm operations ranged in size from 13 ha to 1505 ha, with an average size of 495 ha. The average holding size among landowners was 157 ha. In total, our interviewees owned or operated 9834 ha of farmland, most of which was planted in corn and soybeans, with the exception of 432 ha (4%) which was planted in perennial vegetation as part of U.S. Department of Agriculture (USDA) farm conservation programs. In 2005, our farmer interviewees received an average of $57,015 in USDA commodity support subsidies (the amount of which was based on hectares of corn and soybeans planted) and an average of $5,348 in USDA conservation support payments (EWG 2006). Twelve of our interviewees owned livestock, eight of these in concentrated animal feeding operations (CAFOs). These CAFOs housed hogs (n=6) or turkeys (n=2) and ranged in size from 6,000 to 47,000 head of animals sold per year.

Emergent Themes
Eighteen themes of varying strength emerged through analysis of the interview data (Table 2.2, Fig. 2.2a). These themes encapsulated what was most important to our interviewees about their rural places. Consideration of how these themes related to one another in light of our major study questions led us to understand them in terms of four overlapping groups—countryside, stewardship, independence, and conservation—as described below. Groups of themes were linked and differentiated in interviewees’ experience across biophysical and social scales (Fig. 2.2), and thus some themes are contained in more than one group.
Countryside

This group is comprised of the following themes: farming lifestyle, people on the land, family, rural aesthetics, farming becoming big business, and the economic realities of farming (Table 2.2, Fig. 2.2b). Both farm operators and non-farm rural residents most consistently and strongly spoke of their connection to rural areas in terms of networks of farms and people. “Countryside” emerged through the interview process as the term best able to capture, in the vernacular of our interviewees, this collage of farms, families, and communities interconnected across the landscape. The themes that comprise this set illustrate that our interviewees perceived their countryside as primarily a social, and only secondarily a biophysical, entity.

Out of all interview themes, farmers and non-farm rural residents most consistently and emphatically identified with the “farming lifestyle” (Table 2.2). Interviewees were eager to talk about the rhythms, challenges, and edifying character of farm work and oftentimes did so at length. Childhood experiences and the work ethic instilled through farm life were important to many interviewees. As one non-farm rural resident put it, “Our son needs to be raised in an environment where he is somehow connected to the farming community, learning how to work with his hands next to the intellectual education.” Interviewees relished participation in the cycles of the seasons, of plant and animal growth, and of food production that are inherent in farming. One farmer who ran a large corn, soybean, and hog operation said:

_In farming you're a part of the creation of life. If you don't start out farming having that in you, by the time you're done farming you feel that a little bit. You're doing something; that is, you're seeing life evolve in front of you._

Two of the other most repeated and most strongly-voiced themes among interviewees were highly social in nature: “people on the land” and “family” (Table 2.2). Interviewees valued connections and supportive relationships with neighbors and community members, including church and coffee groups, sharing meals and celebrations, and the ways in which people helped each other out in times of crisis. Many interviewees—and almost all female respondents—told stories that tied their experiences of rural place to family members. The strongest and most consistently-voiced theme relating to biophysical aspects of the
countryside was “rural aesthetics.” Both farmers and non-farm rural residents related to the beauty of the crop rows, the mosaic shades of green across the landscape, and the sights, smells, and sounds of farming.

Interviewees not only appreciated the linked social and biophysical aspects of living in the countryside, but also lamented the ways in which the threads of this once tightly interwoven way of life were unraveling. Farmers especially talked about the way that farming is becoming more corporate and intensive in character. Input costs, land prices, and the “cash rent” that operators must pay farm owners to work the land are all increasing. In turn, profit margins are narrowing, which leads to fewer farmers operating more ground to make a living. This makes it difficult for young operators to get started—a trend mentioned as particularly disturbing to nearly half the farmers we interviewed. Interviewees were eager to discuss how the decrease in farmers, farm families, and return of agricultural revenues to rural communities has led to loss of commerce, amenities, and schools in their towns. The sense of loneliness and powerlessness surrounding these changes was expressed consistently throughout interviews. One farmer in his mid-fifties put it this way:

_The farms are getting bigger now. The people are leaving... When I was [young], my folks, they had some relation around and they always used to do things, you know, get together and do a lot of stuff. They just aren’t around anymore... I’ve got no family around... There are only half the people in the class now as there was when I graduated [from high school]. So they’ve gone somewhere._

**Independence**

In seeming contrast to the desire for connectedness with farms and people, many interviewees also expressed ideas associated with independence including: suspicion of government and regulation, rural aesthetics, distance from people, suspicion of outsiders, being one’s own boss, and private property (Table 2.2, Fig. 2.2c). Many respondents lived in rural areas because they value the freedom to be their own boss and to do what they want to on their own private property. Some interviewees also enjoyed fresh air, open spaces, sunrises and sunsets, the peace and quiet of country living, and being outside. One non-farm rural resident illustrates the desire voiced by many for distance from town and neighbors:

_It’s just so much nicer being out in the country away from people. And yet you’re close enough to where, if you want to go to town, you can go to town... Friends [are] around if you want to go see them, but they aren’t right next door to you... Just very_
few restrictions on what a person can do out in the country, whereas in town you got to consider the neighbor and everything else before you go planting trees or changing anything.

In interviews, misgivings were regularly shared about outsiders, such as new residents and commuters, who were not known or involved in the local community and who did not understand “country living.” About half of our interviewees, most of them male, voiced a suspicion of the government and frustration with government farm programs, especially conservation programs, which were seen as ephemeral and lacking common sense.

Stewardship
Themes in this set included: land/farming ethics, soil stewardship, water quality, farming lifestyle, people on the land, family, rural aesthetics, and the economic realities of farming (Table 2.2, Figs. 2.2b and 2.2d). The majority of the rural people with whom we spoke volunteered a strong ethic related to taking care of one’s land, farm, family, and/or community. While there was much variation in the ethics expressed among different interviewees, the people with whom we spoke generally held that there are better and worse ways to farm. Often interviewees’ ethics encompassed taking care of the land, primarily at infield, on-farm scales (Fig. 2.2d). This included practices such as building soil, preventing erosion, keeping tillage to a minimum, leaving your farm better for future generations, and—to a lesser degree—taking care of water quality. Twelve farmers and three non-farm rural residents, all but one of them male, placed particular importance on using reduced tillage practices to take care of the soil. For example, upon being shown two pictures that we had chosen to depict agricultural landscapes dominated by monoculture corn or soybean agriculture, several of these farmers first remarked on the lack of last years’ crop residue between rows and commented on the farmer’s poor tillage.

As is illustrated by the overlap of the stewardship set and countryside set (Fig. 2.2d), ethics expressed by interviewees not only related to soil conservation, but were equally strongly tied to preservation of farms, families, and the rural way of life. Farmers often explained how careful management and marketing choices allowed their operations to remain profitable despite difficult and complex economic realities. Several farmers and non-farm rural residents complained about large farm operators in the area who were hungry for land,
were not highly involved in the community, and whose tillage and manure application practices were sub-optimal. Interviewees also commented on the upkeep and cleanliness of their neighbors’ farmsteads and fields. Farmers and rural residents who were concerned about air and water pollution from herbicides, pesticides, and CAFOs often emphasized that they were not criticizing farmers in general, but rather certain practices evidenced by only a few of the worst offenders. Interviewees’ approval or disapproval of certain groups of outsiders—such as commuter residents, scientists and academics, city people, and environmentalists—hinged on whether these groups were seen, or not seen, as being supportive of rural farmers and communities. As a farmer who worked with a local watershed initiative stated:

*I went to their latest Midwestern conference out at Nebraska City. And as a farmer, you know The Nature Conservancy, so is that just another ecological group that is down on farmers? No! They want to work with us… on a working landscape.*

**Conservation**

Themes related to perennial conservation practices—including tillage and soil erosion, regional rivers, lakes and scenic areas, wildlife, water quality, natural areas for recreation within farm land, and perennial cover on marginal farm ground—were generally of secondary importance to our interviewees (Table 2.2, Fig. 2.2e). Many respondents brought up infield soil stewardship or enjoyment of regional rivers, lakes, and scenic areas in response to early questions about the countryside in the first part of the interviews. However, themes related to conservation of perennial vegetation at a landscape scale within the agricultural mosaic—such as wildlife, water quality, local natural areas for recreation, and perennial cover on marginal agricultural land—would seldom have been brought up in interviews if perennial conservation practices had not been introduced into interviews through photo elicitation.

Once shown photographs, 36 of the 42 people we interviewed voiced general approval of perennial conservation practices on marginal agricultural land—such as wetlands and riparian buffer strips—and “green” government programs and incentives to support these practices. Such practices were, however, rarely considered a priority for farmers. Restoration of perennial vegetation on productive farm ground, through strip intercropping or
restored prairie, received more mixed responses. While some interviewees approved of these practices, most suggested that they are impractical, time intensive, and better suited to more rolling terrain than that found in the Des Moines Lobe. 86% of both farmers and non-farm residents clearly indicated in interviews that environmental concerns were secondary to farm concerns.

Reasons for approval of perennial conservation practices varied. Nine rural residents, but only two farmers, mentioned the beauty of perennial conservation practices; seven additional farmers talked about the beauty of trees associated with farmsteads or their benefits in wind protection. Farmers tended to view perennial conservation practices in terms of their benefits for regional and downstream water quality. Only three respondents expressed concern with the quality of their own drinking water. Most non-farm residents saw perennial restoration practices as providing local places for recreation (Table 2.2) including walking, riding horses, wildlife viewing, or hunting. Members of both groups approved of the positive impact that landscape scale restoration practices had on wildlife populations (Table 2.2), especially game bird species such as ducks, geese, and Ring-necked Pheasant (*Phasianus colchicus*). White-tailed Deer (*Odocoileus virginianus*) were consistently viewed as an overpopulated nuisance.

**Discussion**

Results from our interview data show that the rural people we spoke with see the countryside in which they live and work as what resilience theorists call a linked social-ecological system (Gunderson and Holling 2002, Berkes et al. 2003). Resilience theory posits that one key to understanding systemic dysfunction and potential in complex systems may be found by looking closely at synergies or mismatches between system components at key scales (Gunderson and Holling 2002, Cumming et al. 2006). We have identified three key scale boundaries inherent in our interviewees’ conceptions of their countryside: the landscape/community interface, the individual/community interface, and community/institution interface. Mismatches between scales at each of these boundaries have the potential to impact both restoration of perennial vegetation and the long-term resilience of rural Corn Belt social-ecological systems. We argue that each of these
boundaries may also identify a leverage point (Meadows 1999) where opportunities to promote perennial conservation practices and bolster regional resilience might be found.

Landscape-community interface

Like previous research conducted near our study site (Wagner and Gobster 2007), we found that rural residents did not readily conceive of their surroundings in terms of a watershed, or readily display acute knowledge of the way that biophysical landscape change impacts the provision of ecosystem goods and services. However, residents displayed a strong conception of their surrounding countryside as a network of people and farms exhibited at the community social scale (Fig. 2.2b). Through the process of initiating interviews in our study site, we found that these networks, although overlapping, were nonetheless identifiable and existed at a similar spatial scale to that often described by a biophysical “landscape” (Fig. 2.1). Countryside social networks have the potential to build understanding of, and support for, restoration of perennial vegetation in locales where landscape-scale conservation is not currently a priority. Our results suggest that conservation initiatives in the Corn Belt that use the concept of countryside to link conservation and stewardship (Fig. 2.2f) are more likely to be assimilated into the social and cultural norms of rural people.

This aspect of our research offers a caveat to work by Nassauer et al. (2007a), who used photo elicitation to determine that farmers preferred the aesthetics, functionality, and societal benefits of landscapes depicting the use of perennial conservation practices to maximize water quality and biodiversity. While our interview data corroborate the finding that rural people respond positively to photographs depicting perennial conservation practices on marginal agricultural land, farmer approval in our study was based almost purely on functional and societal benefits rather than on aesthetics. Further, because our methods prioritized understanding rural residents’ broader perceptions of their place, we were able to assess how conservation practices were tied to other rural priorities. In our interviews, the value of perennial conservation practices was almost always voiced secondarily to farm and community concerns, and the implementation of practices within crop rotations or on productive farmland was almost always seen as impractical and unnecessary. Differences in sampling strategy may also underlie these differences in results. Nassauer et al. (2007a)
targeted comparatively smaller farmers who had demonstrated the ability to be innovative in their land use practices, whereas our study targeted comparatively larger farmers who were civically active in their communities.

**Individual-community interface**

The autonomy of rural people presents a formidable challenge to implementation of landscape scale conservation practices that span private property boundaries. Congruent with other research in the Corn Belt, we found that rural people have strong ethics that motivate the way that they farm, but that these ethics vary a great deal between respondents (Stein et al. 1999, Corselius et al. 2003, Urban 2005). This variety of subjectively held motivations is reflected in the inconsistent participation in farm conservation programs currently observed in the Corn Belt. In addition, although a favorable disposition towards some perennial conservation practices and farm policy that rewards farmers for their implementation was voiced by 96% of interviewees, 65% of active farmers simultaneously voiced a hesitancy to actually participate in these types of programs. As one farmer put it, “There is nothing wrong with the program, I think the program is excellent… I just didn’t want to deal with the government.”

However, while the rural people we interviewed prized their independence, they voiced a much stronger desire for social connectedness (Fig. 2.2, Table 2.2). Two of the themes associated with countryside, “people on the land” and “family farm,” indicated a strong desire for close knit community among our interviewees. In addition, the stewardship ethics voiced by our interviewees were just as strongly tied to care for your family and local community as they were to care for the land. Desire for connectedness and ethics of care are two community-level values that have the potential to bring independent rural people together to achieve common goals, including landscape change.

**Community-institution interface**

The farmer quoted above who did not want to “deal with the government” also voiced, not more than five minutes later in the same interview, regret that consolidation of agriculture, schools, and commerce is having a profoundly negative impact on small communities. When
asked what could be done to counter this trend, he quickly answered, “the government, that’s all I can think about.” In like manner, other interviewees who lamented the decline of rural communities recognized that drastic institutional changes, including government regulations and aid, were needed to reverse this trend. This illustrates another important pattern in our data. The most strongly and positively voiced themes cluster around the interface between the community and individual/household social scales (Fig. 2.2). While state and federal institutions are recognized as having a profound impact on rural ways of life, interviewees view these macro-level forces with distance and suspicion, and voice a sense of powerlessness to affect institutional change.

This mismatch between desire for strong communities and the distrust of institutions reveals a striking challenge for rural areas and for conservation initiatives in these areas. Bellah et al. (1991) define institutions not only as organizational entities, but as “normative patterns embedded in, and enforced by, laws and mores [informal customs and practices].” In interviews with people from all walks of life, they found that Americans mourn the decline of societal benefits arising from strong institutions, but simultaneously view institutions as something external to themselves over which they have little control. Based on our interview data, we argue with Bellah et al. (1991) that to affect lasting change in landscapes and communities ways must be found to bridge the gap between autonomous individuals, households, and communities and the ethical and political dialogue that undergirds strong institutions.

Through her work with Iowa farmers, Morton (In Press) has developed a model to show how community-level civic engagement in watershed management initiatives may help bridge this divide, while simultaneously building social resources and improving water quality. The importance of farm and community networks exhibited by our interview data corroborates Morton’s model. As discussed above, our results suggest that landscape conservation initiatives are likely to be more successful if connected with countryside concerns. But where Morton (In Press) focuses almost exclusively on the lower levels of Flora’s (2004) model of social control (individual values and social norms), our results suggest that higher levels (economic and institutional forces) cannot be ignored. To be
successful, conservation initiatives must not only bridge scalar divides to link landscapes and communities, but must also link individual values with institutional change.

**Conclusions**

We initiated interviews because we were eager to learn how private property boundaries, social norms, and perceptions of place impacted the potential of perennial conservation practices to bolster regional social and ecological resilience. At the spatial scale where we saw landscapes and watersheds, the rural people we interviewed saw farms and communities. While our respondents generally responded positively to pictures of conservation practices that restored perennial cover types on marginal agricultural land, implementation of such practices is currently neither a priority, nor well integrated into rural experience and values. Like biophysical landscapes and watersheds, community scale social norms and networks span private property boundaries and may be instrumental in bridging gaps between individual values, societal goods, ecosystem services, and collective institutions.

**Literature Cited**


QSR. 2006. NVivo7 (qualitative data management and analysis software). QSR International, Doncaster, Australia.


Table 2.1. Characteristics of Hamilton County as compared to the average of all fifteen Iowa counties located entirely or nearly entirely within the Des Moines Lobe geologic formation (USDA NASS 2002, EWG 2006).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Hamilton County</th>
<th>Avg. of Des Moines Lobe Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hectares (ha)</td>
<td>149,365</td>
<td>145,949</td>
</tr>
<tr>
<td>Percent of total land in farms</td>
<td>94%</td>
<td>95%</td>
</tr>
<tr>
<td>Percent cropland</td>
<td>89%</td>
<td>88%</td>
</tr>
<tr>
<td>Percent land in harvested corn and soybeans</td>
<td>84%</td>
<td>82%</td>
</tr>
<tr>
<td>Percent land in perennial cover types</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Percent land in govt. conservation programs</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Cattle and calves sold (number)</td>
<td>5,701</td>
<td>16,564</td>
</tr>
<tr>
<td>Hogs and pigs sold (number)</td>
<td>1,270,158</td>
<td>556,630</td>
</tr>
<tr>
<td>Average size of farm (ha)</td>
<td>177</td>
<td>175</td>
</tr>
<tr>
<td>Median size of farm (ha)</td>
<td>96</td>
<td>107</td>
</tr>
<tr>
<td>Farms (number)</td>
<td>797</td>
<td>790</td>
</tr>
<tr>
<td>Corn and soybean subsidies 2005 (U.S. $)</td>
<td>26,582,426</td>
<td>24,581,155</td>
</tr>
<tr>
<td>Conservation Subsidies 2005 (U.S. $)</td>
<td>1,913,244</td>
<td>1,619,051</td>
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</tbody>
</table>
Table 2.2. The major themes that arose from qualitative analysis of our interview data are listed in order of importance (♀=female interviewees; ♂=male interviewees; fm = farm operator interviewees; nf = non-farm rural residents).

<table>
<thead>
<tr>
<th>Theme</th>
<th>Description</th>
<th>Quote</th>
<th>Interviewees Expressing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Farming Lifestyle</td>
<td>Work, rhythms, and activities of farms are valued. Both farmers and non-farm residents consider maintenance of farms and farmers a rural priority.</td>
<td>“I like working with livestock. My kids were all in 4-H and showed cattle at the county fair, and I enjoyed working with that, and it was kind of a bonding time for them and me, working together. And I like the harvest. I like to watch the crop come in.”</td>
<td>83% Emphasized; 14% Important</td>
</tr>
<tr>
<td>2. People on the Land</td>
<td>Interviewees value social networks among neighbors and community members. Loss of people from the land and decline in schools and commerce is mourned.</td>
<td>“Oh, in an ideal world, we’d go back 50 years. I’d go back to when there was people in the country. Look at these little towns that are drying up. There’s just nothing left. Schools have a big problem.”</td>
<td>71% Emphasized; 17% Important; 2% Secondary</td>
</tr>
<tr>
<td>3. Family</td>
<td>Farms and rural areas are seen as a good place to raise children. Relationships with and stories about past and present family members are often emphasized.</td>
<td>“This was my grandparents farm… It’s the same dirt, it’s the same [gets teary-eyed; laughs]… It’s a partnership, it’s a family business, it’s traditions that you carry on, and you can do things that your grandparents did.”</td>
<td>60% Emphasized; (91%♀; 48%♂) 33% Important</td>
</tr>
<tr>
<td>4. Rural Aesthetics</td>
<td>The beauty of crops and animals, well kept farmsteads, the many shades of green, open spaces, fresh air, and peace and quiet are all valued aspects of country living.</td>
<td>“Iowa is phenomenally beautiful, because all the corn stands tall and nice and we talk many times, you can drive through the countryside and… you probably could come up with a thousand different shades of green.”</td>
<td>48% Emphasized; 31% Important</td>
</tr>
<tr>
<td>5. Farming Becoming Big Business</td>
<td>Agricultural intensification and consolidation, increasing land prices, loss of local ownership and revenue, and competition for land is changing rural life.</td>
<td>“I’m afraid that conglomerates are going to step in and take over and, the little farmer, he ain’t gonna have a word to say… You’re going to be a hired man again is what it boils down to me in my mind.”</td>
<td>33% Emphasized; (46%fm; 7%nf) 55% Important</td>
</tr>
<tr>
<td>6. Land / Farming Ethics</td>
<td>There are better and worse ways to farm. The ways that people care for their land and their families and relate to neighbors and the community matter.</td>
<td>“They didn’t touch those corn stalks last fall. Everybody else I know, they’re doing fall plowing and you got black soil all the way around…. Whoever is farming this… they are really doing a responsible job… I’m just real happy with the way they farmed.”</td>
<td>29% Emphasized; 52% Important; 10% Secondary</td>
</tr>
<tr>
<td>7. Economic Realities of Farming</td>
<td>It is getting harder and harder to raise a family on a farm income. Production costs are high and even large farm operators often make only a small return per unit land.</td>
<td>“Most [farmers] have a job in town or they are custom feeding for somebody. You know, they aren’t really doing it the way that it has always been done in the past. Everybody does what they have to—to earn a living.”</td>
<td>29% Emphasized; (0%♀; 39%♂) 52% Important</td>
</tr>
<tr>
<td>8. Suspicion of Government &amp; Regulation</td>
<td>Government is an untrustworthy outsider. Government farm programs are associated with bureaucracy, red tape, hassles, poor implementation, and are seen as ephemeral.</td>
<td>“…but it does complicate farming, ‘cause you got, you got to follow the rules, and sign contracts and, you know? That’s the only thing I’m uneasy about is… you sign… a piece of your independence away.”</td>
<td>24% Emphasized; (0%♀; 32%♂) 31% Important; 5% Secondary</td>
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<td>Table 2.2 cont.</td>
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<tr>
<td>9. Distance from People &amp; Suspicion of Outsiders</td>
<td>Being removed from the hustle and bustle of town and the watchful eyes of neighbors is valued. People who are not active in the local community are viewed with distrust.</td>
<td>“[I like] being away from everybody… Just being away. You don’t walk out, and there’s neighbors watching what you’re doing… Nobody bothers you…I don’t wanna live in town. I’d hate it.”</td>
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<tr>
<td>10. Own Boss &amp; Private Property</td>
<td>The ability to be your own boss is voiced as a reason for both farming and living in the country. Private property is valued as a great good.</td>
<td>“When I got started, I was my own boss. I made a boo-boo, it was my fault. Things went well, we profited from it.” “Just very few restrictions on what a person can do in the country.”</td>
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<td>11. Tillage &amp; Soil Erosion</td>
<td>Soil erosion is a concern and minimum tillage practices were one mark of a careful farmer. Interviewees pick these practices out of photos and talk about how they till.</td>
<td>“It impressed me that he was so conservation minded. There isn’t too many people that are drilling beans in a corn stubble like that… This guy did nothing. He drilled it [the seed] right in those stalks.”</td>
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<td>12. Regional Rivers, Lakes, &amp; Scenic Areas</td>
<td>Regional water bodies and scenic byways, parks, and preserves—areas outside of, but connected to the agricultural mosaic—are valued as places for recreation and retreat.</td>
<td>“I like some of the natural resources we have, and from this house I can’t see them, but there’s some lakes around, and I like to go fishing sometimes. And there’s the Boone River; we like to canoe down that.”</td>
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<td>13. Wildlife</td>
<td>Wildlife and habitat are valued for hunting, observation, or for their own intrinsic value—either within the agricultural mosaic or at regional marshes, lakes, and rivers.</td>
<td>“They’re [deer when not on roads] kinda cute to watch. Since the wetlands program, there’s so many more species of birds and wildlife that has come back to our area.”</td>
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<tr>
<td>14. Water Quality</td>
<td>Animal manure and agricultural fertilizers, herbicides, and pesticides are recognized as a threat, or a perceived threat, to local and downstream water sources.</td>
<td>“I think it’s important to, well, do whatever we can to keep our water clean, especially if, I think the situation down the gulf of Mexico is gonna end up making us use less fertilizer.”</td>
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<td>15. Natural Areas for Recreation within Farm Land</td>
<td>Some interviewees, primarily non-farm rural residents, value interconnected natural areas such as wetlands and stream buffers for walking, biking, hunting, or wildlife viewing.</td>
<td>“Just to, uh, hear all that stuff, all the birds, different birds. Oh, our kids love taking the grandkids out through that, and letting them see that, and riding their bikes, and little things. It’s one of the I guess perks of living here.”</td>
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<td>16. Perennial Cover on Marginal Farm Land</td>
<td>Although rarely a priority, many interviewees respond positively to pictures of perennial cover types (buffers, wetlands) on marginal agricultural land to help water and wildlife.</td>
<td>“There’s no need to pull tile [underground soil drainage system] out of good productive farmland… But if it’s ground that you’re having trouble keeping dry, yeah, that might pay to make it into wetland. Help water quality…for us and for the fish.”</td>
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</table>
Fig. 2.1. Our study site is a network of farms and communities in Hamilton County, Iowa that overlaps with both the headwaters of the Squaw Creek Watershed and the rural South Hamilton School District.
Fig. 2.2. Major themes emerging from qualitative analysis of interview data are oriented according to overlapping biophysical and social spatial scales (2a). Themes in larger and bolder font were voiced more strongly and consistently across interviewees. Placement of themes is an approximation; many themes were discussed at multiple scales. The themes most important to our interviewees tended to cluster at more local scales in more social arenas. Arcs denote groups of themes that were found to be closely related to one another: (2b) countryside, (2c) stewardship (2d), independence, and (2e) conservation. Note that some themes are exhibited in multiple groups. Interview data reveal three boundaries between biophysical and social scales (2f) at which key challenges to, and opportunities for, perennial conservation practices and regional resilience are exhibited.
CHAPTER 3.
LINKING RESILIENCE AND DIFFUSIONS OF INNOVATIONS THEORIES TO UNDERSTAND THE POTENTIAL FOR PERENNIALS IN THE U.S. CORN BELT

A manuscript in revision for the journal *Ecology and Society*

Ryan Atwell, Lisa Schulte, and Lynne Westphal

Abstract
In the last 200 years, upwards of 80% of the land in the U.S. Corn Belt agroecosystem has been converted from natural perennial vegetation to intensive row crop agricultural production. Despite research showing how re-integration of perennial vegetation (e.g., cover crops, pasture, riparian buffers, and restored wetlands) at strategic landscape positions can bolster declining regional ecosystem function, the land area devoted to row crop production in the Corn Belt continues to grow. As this region enters a time of fast-paced and uncertain reorganization driven by the emerging bio-economy, changes in land use will continue to take place which will impact the resilience of the Corn Belt’s linked social and ecological systems for years to come. ‘Resilience’ and ‘diffusion of innovations’ are two theories that investigate how change is brought about in systems through the adaptation and innovation of social actors. In this paper, we integrate these two frameworks in the analysis of 33 in-depth interviews with people from a rural community in Iowa, USA to improve understanding of how rural Corn Belt stakeholders make conservation decisions in the midst of an uncertain future. Interview data indicate that adoption of conservation practices is based, not simply on immediate profitability, but upon the interplay between contextual factors at three distinct levels of the system: 1) compatibility with farm priorities, profitability, practices, and technologies; 2) community-level reinforcement through local social networks, norms, and support structures; and 3) consistent, straightforward, flexible, and well-targeted incentives and regulations issuing from regional institutions. Interviewees suggest that the multi-scale drivers that currently support the continued expansion of row crop production could be realigned with conservation objectives in landscapes of the future. Adaptation of social actors through collaborative learning at the community level may be instrumental in brokering the sort of multi-scale system change that would lead to more widespread adoption of perennial cover types in the Corn Belt.
Introduction

Change is both a disruptive and renewing force in natural and human systems (Gunderson and Holling 2002, Walker et al. 2006). When change is driven by collective human decision making, its ramifications can be very difficult to predict because many plausible courses of action may be chosen. In natural resource management, the dynamic decisions of social actors often heighten the difficulty involved in addressing what are already complex ecological questions.

This is the case in agro-ecosystems of the North Central U.S. Corn Belt, a region with a long history of change which has been based upon the interplay of natural processes and the decisions of its human inhabitants (Axelrod 1985). This region is currently undergoing a period of rapid and uncertain reorganization driven by an increased demand for bioenergy crops (Hinkamp et al. 2007). Despite ecological and social deficits associated with agricultural intensification, the amount of land devoted to row crop production is continuing to increase in response to commodity markets, public policies, cultural norms, and farmer decisions (Secchi et al. 2008). While problems inherent in this trajectory are recognized (Duffy 2006, EPA Science Advisory Board 2007), it is unclear how they might be addressed in the midst of an uncertain future.

Resilience theory (Gunderson and Holling 2002) and diffusion of innovations (Rogers 2003) are two interdisciplinary avenues of inquiry that focus on how human decision-making can influence, and can be influenced by, the process of change. Resilience theory is rooted in the ecological sciences, is in its theoretical adolescence, and is currently receiving widespread attention and application among scientists and practitioners from diverse fields (Liu et al. 2007). Resilience theory is also receiving criticism in some quarters for weak integration and appropriation of social science theory and methodologies and for oversimplifying complex problems in order to incorporate complex social phenomenon as quantifiable variables in systems models (Harrison 2003, Jannsen et al. 2006, Christensen 2008). In contrast, diffusions of innovations is well-established and is based on more than 60 years of empirical research, including both qualitative and quantitative studies (Rogers 2003). But in the last two decades, the inertia of this field has dissipated as questions for future study demand foci and methodologies different from those of past diffusion research,
including greater understanding of the sort of multi-level and ecological system drivers that are the focus of resilience theory (Fliegel and Korschling 2001, Wejnert 2002, Rogers 2003).

We have found resilience and diffusion of innovations to be complementary explanatory packages that, when taken together, allow us to rigorously probe how rural stakeholders in the Corn Belt make decisions that affect conservation outcomes. Here we employ these two frameworks in the analysis of data from in-depth interviews. We posit that, together, these theories work to explain how socio-cultural context constrains, or enhances, adoption of conservation practices by rural stakeholders.

**Dysfunction in the Corn Belt**

In their attempts to optimize one or more components in a complex system, humans often dampen the natural variability and resilience of other components (Gunderson and Holling 2002, Walker et al. 2006). Such is the case in the North Central U.S. Corn Belt, where optimization of agricultural production by controlling other key system variables (commodity crop markets, nutrient levels, herbicide and pesticide application, surface water removal, wetland drainage, stream channelization) has lead to loss of dynamic system characteristics over time (e.g., natural pest and flood control, diversified farming systems, rural commerce and population, water purification; Keeney and Kemp 2002, Schulte et al. 2006, Nassauer et al. 2007).

In the last decade, ecological imbalance in the Corn Belt has become a problem of national priority. High levels of nutrients associated with agriculture (nitrogen and phosphorous) in the region’s rivers have been implicated as the primary driver of the downstream Gulf of Mexico hypoxic dead zone (EPA Science Advisory Board 2007, Nassauer et al. 2007). Recent research shows that the increasing nitrate levels in the contributing rivers are best explained by a decrease in the amount of perennial crops and pasture in agricultural watersheds over the last several decades (Hatfield et al. 2008). These trends are expected to continue in the near future with the emergence of corn-based ethanol (Secchi et al. 2008), although in the long term the emerging bio-economy (Hinkamp et al. 2007) may present opportunities for system re-organization.
Agricultural intensification has also been linked with regional social dysfunction. From 1950 to 2002, the portion of revenue from the sale of agricultural products that was returned to farmers decreased from 37% to 19%, while farm input costs increased sevenfold and the real price of corn (adjusted for inflation) decreased five-fold (Duffy 2006). The region is losing once numerous, mid-sized, owner-operated farms, while large and corporate farms, owned by outside investors, are increasing in number and size. Although the federal government spent over 2.2 billion dollars in 2005 in the state of Iowa alone on U.S. Department of Agriculture (USDA) agricultural support programs (EWG 2006)—and nearly 40% of the income of regional corn and soybean farms comes from government payments—much of this funding benefits “absentee” farm owners rather than local operators or rural communities (Duffy 2006).

Research suggests that restoration of perennial vegetation within relatively small portions (5-15%) of the rural Corn Belt landscape may disproportionately benefit the region’s long-term ecological and social resilience (Schulte et al. 2006, Nassauer et al. 2007). Such perennial conservation practices may include the use of cover crops, pastures, well-managed multi-species riparian buffers and wetlands, and concentrated areas of remnant and restored forest and prairie. However, with upwards of 95% of the land in the Corn Belt in private ownership (USDA NASS 2002), conservation practices must be implemented by farm owners, operators, and rural residents across property boundaries if landscape scale objectives, such as clean water, are to be achieved. At the present time, perennial conservation practices are neither a rural priority nor well integrated into rural culture (Chapter 2).

Resilience, scale, adaptation, and innovation
Resilience theory emphasizes that ecological and social systems are inextricably linked, and that their long-term health is dependent upon change, including periods of both organization and growth, as well as periods of collapse and reorganization (Gunderson and Holling 2002, Walker et al. 2006). It is proposed that the complexity inherent in dynamic social-ecological systems often hinges upon the interaction of a relatively small number of three to six critical variables and processes that operate over distinctively different spatial and temporal scales.
(Gunderson and Holling 2002). In addition to space and time, sociological conceptions of scale also consider how humans symbolize reality at different organizational levels (Pritchard and Sanderson 2002, Westley et al. 2002, Cumming et al. 2006). The innate human tendency to create meaning gives us the ability both to construct the landscape through implicit social norms and explicit group discourse, and to manipulate its future cycles through management and technological initiatives.

For this reason, human adaptation is an essential component in the resilience of complex social-ecological systems, and resilience theorists have called for a pragmatic approach to understand “where resilience resides in the system, and when and how it can be lost or gained” (Walker et al. 2002, 3). This includes identifying “roadblocks and opportunities for adaptive capacity and innovation” (Pritchard and Sanderson 2002, 166), as well as “points of intervention where one can increase resilience of desired configurations to future changes, including those that are unforeseeable” (Walker et al. 2002, 3). Resilience theory highlights the adaptability of human social actors whose collective choices and behaviors can erode or bolster system resilience, or can transform a system into a more or less resilient state (Gunderson and Holling 2002, Walker et al. 2006). Resilience theory suggests that key system components, and the focal scales at which they interact, are often best identified through strategies that partner experts with stakeholders who understand the system from different scales and perspectives (Walker et al. 2002, Westley et al. 2002).

Diffusion of innovations is a field of research that investigates how new ideas spread in a populace (Rogers 2003). Diffusion theory emerged in the mid-twentieth century from studies in several disciplines, including seminal studies on the adoption of row crop agricultural production technologies by Corn Belt farmers (Ryan and Gross 1943). Research and theory on the diffusion of innovations indicates that most people decide to adopt an innovation based primarily on subjective values and social norms, diffused through interpersonal networks, rather than rational reflection upon scientific data (Ryan and Gross 1943, Coleman et al. 1957, Rogers 2003). The example set by opinion leaders, who often have connections both inside and outside a local community, can serve to broker adoption across societal boundaries (Burt 1999, Rogers 2003). Because diffusion of innovations has a long history of research in the Corn Belt, it may offer key insights into how perennial
conservation practices can be integrated into row crop production systems through adoption by farmers in privately-owned, working landscapes.

Current diffusion research on conservation practices has been largely built on retrospective, survey-based studies which link the timing of innovation adoption with social and demographic data (Fliegel and Korsching 2001, Wejnert 2002, Rogers 2003). Yet because diffusion is a social phenomenon, and because not all innovations are successfully diffused or found to be beneficial in their cultural contexts, it has been widely suggested that “positioning research” to understand the efficacy of potential innovations is needed (Fliegel and Korsching 2001, Wejnert 2002, Rogers 2003). These theorists also posit that such research might utilize either qualitative or systems approaches, such as those employed in many resilience studies, to understand the interplay between multi-scale drivers of change, which are often difficult to quantify and compare directly. Our research utilizes such an approach to understand the socio-cultural efficacy of, and potential for, increasing perennial vegetation in Corn Belt agroecosystems.

In this study, we evaluated how the adoption of perennial conservation practices by rural stakeholders from in a Corn Belt landscape in Iowa, USA is constrained or enhanced by social and ecological factors at multiple scales. Our study questions included: a) Why and how would farmers adopt practices that increase perennial vegetation on their landscapes? b) What factors stand in the way of adoption? c) How can restoration strategies be most effectively disseminated within the multi-scalar social-ecological context of the rural Corn Belt?

**Methods**

**Study area**

Our study area is an agricultural community encompassing the headwaters of three small watersheds, roughly coinciding with the western half of the South Skunk School district, and surrounding the rural town of Stanhope, Iowa (Chapter 2). Stanhope lies in Hamilton County in central Iowa, which is turn situated in the Des Moines Lobe, an eco-region of the Corn Belt that has been identified as contributing disproportionately to Gulf of Mexico hypoxia (EPA Science Advisory Board 2007) due to the high incidence of underground field drainage
networks. Hamilton County is one of 15 Iowa counties located entirely within the Des Moines Lobe and is representative of this ecoregion in its high preponderance of row crop agriculture, high levels of concentrated animal production facilities, consolidation of agriculture into large farms, loss of farmers, and increase in non-farm rural residents (Table 3.1). All three of the watersheds within our study site are currently targeted by research and management initiatives whose aim is to better understand and influence the interplay between agricultural intensification, ecosystem services, and rural social vitality.

Sampling Strategy
The goals of our research were to understand how shared values and norms influence collective behavior. We used nonprobability sampling techniques (Handwerker 2005), which are common in qualitative and cultural research, to study a smaller number of cases that are particularly relevant to our study questions in greater depth. In this way, our aims and methods differ from those of quantitative studies where a representative sample is drawn from a large number of cases in order to generalize to a broad population. As is common in qualitative research, we did not choose our sample size beforehand, but worked inductively and systematically towards “theoretical saturation” (Neuman 2003), the point at which enough cases were explored to thoroughly elucidate the questions and concepts under investigation.

We used a multi-stage, nonprobability sampling design to choose interviewees (Handwerker 2005). Ethnographic techniques (Spradley 1979, Handwerker 2005) were used to gain entrance into our community of study, and informal conversations about our research were initiated with rural stakeholders during visits to local gathering places (e.g., churches, restaurants, farm supply co-ops). We presented ourselves as researchers from Iowa State University studying how rural people valued the places they lived, with the goal of evaluating and recommending improvements to agricultural and conservation practices. Based on insight gained from discussions with residents of our study site, we used purposive sampling (Neuman 2003, Handwerker 2005) to choose initial participants for in-depth interviews who represented a diversity of local perspectives within the following overlapping groups: farm operators, farm owners, non-farm rural residents, rural opinion leaders, and
local conservation personnel. Among these groups, we prioritized interviewing opinion leaders whose behavior, decisions, and influence were recognized by other community members as impacting sizable portions of the landscape (>200 ha). Snowball sampling techniques, in which ongoing interviews and continued ethnographic work generated more interview contacts, were used to choose interview subjects who represented the above categories until we had reached theoretical saturation in relationship to major study questions.

During initial visits to gathering places in our study site, we found local people to be suspicious of our intentions and reticent to talk. A breakthrough came when a group of local women took an interest in our research project and volunteered contact information for several local farmers, some of whom were their family members. Due to their referral, several farmers consented to be interviewed. These interviewees helped us choose other subjects who were representative of groups that we wished to interview. With the help of a local name and reference, scheduling interviews became much easier. In the end, only three people whom we asked to participate in in-depth interviews declined to talk to us.

**Ethnographic in-depth interviews**

Interviews followed an open-ended guide—while similar questions were asked and similar topics were covered, the exact wording and flow of questions varied between interviews. Interviews included three sections. The first section began with the broad question, “What is most important to you about the rural countryside?” Here we probed how interviewees perceived the natural landscape, how they viewed their neighbors, communities, and institutions, what challenges they saw facing their rural area, and what local assets and amenities they most valued. In the second section, we used 14 pictures of Corn Belt agricultural landscapes to elicit participants’ evaluations of different land uses and cover types. Photos were selected to represent a suite of potential landscape scenarios that varied from maximization of row crop production at one end of the spectrum to a high concentration of perennial conservation practices at the other. Each interview closed by: 1) asking interviewees where they got advice and information on agricultural and conservation practices, 2) reviewing important aspects of our conversation, 3) and asking each participant
to share their vision of what they would like the local landscape to look like 25 years in the future.

**Qualitative data analysis**

Interviews were recorded and transcribed. Transcripts were imported into the NVivo7 data management and analysis software package (QSR 2006). This software package was used as an aid in identifying and developing themes in the data in several ways. Interview data were coded (Miles and Huberman 1994) into descriptive and topical categories by the lead author (Chapter 2). Some of these categories were determined a priori based on our study questions, while others emerged from the data or from comparing and contrasting the data with theoretical considerations. Themes in the data were identified by analyzing the chunks of interview data assigned to different codes in several ways (Ryan and Bernard 2003). Themes reflected recurring concepts expressed by interviewees and were also identified by comparing similarities and dissimilarities in the data, by looking at the use of key phrases, metaphors and stories, and by sorting and assigning coded data into different hierarchical groupings.

Iterative rounds of analysis were used to further scrutinize how the data reinforced or contradicted themes and with what caveats, as well as how themes were related to one another, to study questions, and to theoretical considerations. Here the text searching, sorting, and crosstab capabilities of the NVivo7 software were used to analyze how parts of interview text assigned to different codes related to one another, to emerging themes, and to various attributes of our interviewees’ backgrounds (QSR 2006). The second and third authors each read a random, non-overlapping one-third of the interviews to ensure that analysis was consistent, valid, and confirmable. All authors compared coding choices and worked together using triangulation (Neuman 2003, Ryan and Bernard 2003) to develop consensus on the meaning and identifying features of themes in the data. After reaching consensus, transcripts were re-read and re-coded by the lead author to more thoroughly analyze the agreed upon themes.
Results

Interviewee characteristics

We completed 33 in-depth interviews with 42 participants. Several interviews were conducted with pairs, usually husband-wife couples. Although these pairs often spoke in unison, in several instances we noted differences in perspective that were relevant to our analyses. Interviews lasted an average of 74 minutes, and generally took place in participants’ homes. Eleven of our 42 interviewees were women, and 31 were men; 28 were farm operators and 14 were non-farm rural residents. Twenty-six interviewees owned farmland—including 2 non-farm rural residents and 24 farm operators. Five of the farm operators we interviewed were retired. The majority of the non-farm rural residents we interviewed worked within our study area, while four commuted between 20 km to 120 km to their places of employment. Thirty-seven interviewees were raised in rural areas, and 31 grew up within 20 km of our study site. Our participants were active in formal and informal civic organizations such as churches, coffee groups, farm and service organizations, municipal boards, and fraternal societies.

The 23 active farm operators that we interviewed averaged 51 years old and ranged in age from 23 to 64 years old. Of these farmers, 19 received 50% or more of their household income from farming. Farm operations ranged in size from 13 ha to 1505 ha, with an average size of 495 ha. The average holding size among farm owners was 157 ha. In total, our interviewees operated or owned 9834 ha of farmland, nearly all of which was planted in corn and soybeans, excepting 432 ha (4%) planted in various forms of perennial cover as part of USDA farm conservation programs. In 2005, each of our farmer interviewees received an average of $57,015 in USDA commodity support subsidies and an average of $5,348 in USDA conservation support payments (EWG 2006). Twelve of our interviewees owned livestock, eight of these in concentrated animal feeding operations (CAFOs). These CAFOs housed turkeys (2) or hogs (6). Turkey operations averaged 38,000 head sold per year, while hog operations ranged in size from 6,000 to 47,000 head of animals sold per year.
Themes and scales

Through qualitative analysis, we determined that 12 themes of moderate strength emerging from the interview data were most cogent in addressing our study questions (Table 3.2). When we considered the interrelatedness of these themes within and between interviewees, we found a good deal of variation in individual perspectives. However, when taken together, these themes grouped into three strong classes that were consistent across interviewees—farm compatibility, community reinforcement, and institutional transparency. Each of these classes of themes corresponds to a particular biophysical and social scale (Fig. 3.2). Although overlap between analogous biophysical and social scales is not exact, their correspondence emerged from, and was helpful in explaining, interview data. Each of these three classes and their supporting themes are explained below.

Farm compatibility

Eighteen of the 23 active farmers whom we interviewed indicated that their evaluation of, and willingness to adopt, perennial conservation practices was strongly influenced by how these practices were or were not compatible with their current farm operations. Four themes describe farmers’ evaluations of these perennial practices: 1) how did these practices interface with current farm priorities, 2) would these practices increase or detract from the profitability of their farming operations, 3) did these practices mesh with their current farm practices, and 4) were these practices compatible and supported by current farming equipment and technology? Because these four themes overlap, we explain them together below.

Thirty-six of the rural people we interviewed (including both farmers and non-farm rural residents) offered general approval of perennial conservation practices on marginal agricultural land, such as restored wetlands and riparian buffer strips. One farmer, who farmed 324 ha of corn and soybeans, took 27 ha out of production and put it into a federal wetland conservation program because it was poorly drained and routinely experienced flooding. He explained his rational as follows:

*Me and the neighbor lady went up 15 years ago, and it was 300 bucks an acre for another tile line [to provide underground field drainage]. Well, nobody could stand that kind of cost so we just kind of tabled it, just suffered with it, 'til they came out*
with the wetlands [federal conservation program]… Well one of the neighbors up north here, he was kind of making fun of me one day. I was complaining about all these waterways coming down here and he goes ‘you know, if you were smart, you’d put that in wetlands.’ He said it kind of abusive. And I sat around and thought, ‘you know, you’re right.’… That was the best thing I’d ever done. Oh, I’d had to fight those fields!

Many farmers indicated that new trends in agricultural technology may make implementation of buffers and wetlands more compatible with their agricultural production strategies in the future. For example, 19 farmers expressed that, with increasing sizes of farm equipment, they wanted to farm long, straight rows and would therefore be in favor of adding extra land to conservation set asides in order to square their field borders and make the boundaries of the set asides easier to negotiate. In another instance of technology aiding conservation, five farmers mentioned that precision agriculture using GPS helped them to better identify which lands were worth planting and which were better left out of production.

Three interviewees voiced approval and 14 voiced distaste for perennial cover in the form of more diverse cropping rotations or strip intercropping on productive agricultural land. Those who expressed negative viewpoints toward these practices saw them as more appropriate for landscapes with greater topographical complexity than is found in the Des Moines Lobe physiographic region. Several farmers mentioned that changes in equipment, difficulties in applying herbicides and pesticides, and decreases in crop productivity associated with more diverse systems were an impractical burden having more implicit costs than payoffs. Ten farmers volunteered that, if it were profitable, they would grow a monoculture perennial, such as switchgrass.

Thirty-three interviewees (including both farmers and rural residents) emphasized that conservation practices were not cheap to implement and that farmers needed monetary incentives to make them feasible. One farmer interviewee, who operated his family’s 445 ha corn and soybean farm, had recently added 40 ha of the estate to a federal wetland conservation program. This is how he explained his decision:

Well, they [the federal government] paid us. If they didn’t pay us, we wouldn’t have done it… Well, I think these [conservation set aside] programs are a good thing, but they’ll never happen unless there is a government program paying you to do it. You can’t afford to pay $4000 per acre for land and then let it sit there and look pretty; you can’t do it.
Eight farm operators and owners emphasized that, because of changing land tenure, financial incentives to place farm land in conservation programs often benefit the land owner rather than the farm operator. This is because some federal farm programs (such as the Conservation Reserve Program) give a direct payment to farm owners for taking land out of production. When other programs (such as the Conservation Security Program) give a direct payment to farm operators for conservation practices, land owners often raise the cash rent paid by the operator who farms the land in order to capitalize on this form of income. This is problematic because, on any given farm, either the farm owner or operator may have a more intimate connection with the land and be the primary catalyst of a conservation decision. The comments of two farmers who rent most of their farm ground summarized this problem:

_You want to remember that... 50% or more of the land in Iowa is owned by people who do not farm. And it’s growing more all the time. Outside investors are coming in. And so the people that are farming the land and responsible for caring for the land don’t own it._

_Every time we do that [adding land to federal conservation programs], it takes ground out of what we are farming. I actually talked a landlord into putting 9 acres in CRP [Conservation Reserve Program] last year. Land that one year you grow bumper crop, the next year you drown out... So she put another 9 acres in, which took money out of my pocket. I don’t get any income off that land anymore. Some of that stuff you just do... I would have liked to have seen me get some benefit out of doing that... I did all the leg work to make it happen. I offered to do it cause in the long run, I thought it was going to benefit the ground and benefit everybody involved._

The latter of these two quotes illustrates the struggle to balance competing priorities (in this case income, time, ethics, and norms) that was voiced by many farmers when describing conservation decisions. Thirty-four of the rural people with whom we spoke stressed that it is increasingly difficult to make a living through farming. Adopting a new agricultural practice takes a good deal of time, effort, and risk. Farmers emphasized that, although they may approve of a practice, its implementation must compete with a number of other farm priorities. Many farmers told us stories about the challenge of continuing to run a profitable operation in the midst of decreasing profit margin per unit land and increasing competition for land among operators looking to expand their operations in order to maintain profits. With only a decade or so until they retire, and with no one to take over the farm after they are finished farming, seven of our farmer interviewees indicated that they are not
looking to make innovative changes in their farming or conservation practices. A 64-year-old farm owner and operator said:

*We’re at the edge where we don’t know whether to quit or wait. I got one boy that lives in Sioux Rapids and [pause] he’s got a nice house, a wife, a family. I can’t really encourage much; he kind of has to decide on his own... I’d quit today if he’d come back and farm.*

**Community reinforcement**

Four themes describe the ways in which interviewees’ evaluations of perennial conservation practices hinged upon relationships with members of their local community: *face to face communication, local social networks, cultural social norms,* and *local support structures.*

As described in our methods, face-to-face communication and utilization of local social networks was crucial in gaining entry into our study site, and interview data demonstrate that cultural norms and community-level support systems play an important role in shaping both agricultural and conservation decisions.

During interviews, 15 of the people we talked to volunteered that some form of face-to-face communication, similar to that involved in in-depth interviews, was essential for increasing public understanding and acceptance of perennial conservation practices. Several farmers also indicated that the conversational approach involved in our in-depth interviews made the experience more valuable than they had expected. One large corn, soybean, and hog farmer’s comment summarizes this change in attitude that we often encountered over the course of the interviewing process:

*I think the most important thing is doing just what we’re doing, talking about it [pause]—for us to understand where you’re coming from and the job you’re trying to do, and for you to understand, from a practicality standpoint, what works and doesn’t work. [long pause] Because if we can’t—I don’t mean to set this up as we’re two opposing sides, I don’t mean that at all—but in doing what you’re trying to do or trying to understand, and in working with us, I mean the first thing is to sit down and have a dialogue. You know, without that you’re never going to accomplish anything.*

Community-level social connections were expressed as very important to rural stakeholders. Thirty interviewees emphasized, and all other interviewees discussed, the importance of their neighbors, social networks, and rural communities. Declines in the number of people on the land, in rural social cohesion, and in community commerce and vitality were often mourned. Thirty-eight interviewees made comments illustrating ways in
which compliance with cultural norms are monitored, praised, and/or sanctioned. Their viewpoints illustrate that our interviewees scrutinize their neighbors’ practices and are influenced by their neighbors’ opinions. One large corn, soybean, and hog farmer describes interactions with his non-farm neighbors:

> And I’ve had two people that own acreages that I farm land around. When I sprayed this last time, they came out and talked to me as I was leaving the field… And they thanked me for coming to their farm when the wind was blowing away from the acreage.

Two other livestock farmers emphasized that, with rising rural tensions over livestock odor, it is increasingly important that farm operators invest in relationships of mutual understanding with their neighbors. Recall also how, in the first quotation in the previous section, two neighbors are included in the account of that farmer’s decision to put land in a conservation program, one of whom had expressed an influential, socially normative point of view.

Through ethnographic and interview data, we were able to identify social networks comprised of the interconnected relationships between community members and centered around gathering spots and events that were consistently referred to across interviews. These networks, places, and events were voiced as important in brokering information related to both agriculture and conservation land use. For example, one such location, which emerged as both a gathering/coffee spot as well as a hub of farming information, was a business that sold agricultural supplies and chemicals. This business employed community members and farmers in a number of different capacities, including the role of trained agronomists. These agronomists were trained by national agribusiness corporations to disseminate technical information about their products and related farming advice to their farmer peers at a local level. Fifteen of the active farmers we talked to indicated that local agronomists such as these were their primary source of farm advice, despite the fact that nine of these same farmers (in addition to seven other active farmers, five retired farmers, and nine non-farm rural residents) expressed concern about the encroachment of corporate control on local farming. Although they may voice suspicion in regards to this external, corporate control over local agricultural practices, our interviewees were generally willing to trust the agronomists’ advice because of their peer connection.
Similar to their role in transfer of information about practices related to production agriculture, social connections were also voiced as a key factor in disseminating information about, and facilitating adoption of, conservation practices. Six farmers who had positive experiences with conservation programs mentioned the helpful nature of conservation personnel, whereas eight others suggested that a lack of connection with local agents was one reason they were frustrated with, or unwilling to implement, conservation programs. The owner and operator of a 178 ha corn and soybean farm was proud that a local conservation agent had come to his farm and given him a positive evaluation of his tillage practices:

*He praised me for the residue I had up at the time. He told me I was doing a good job... It’s nice that he has more of a laid back approach and tries to work with people rather than just standing up and telling them. That can turn you off.*

One of our interviewees who had grown up and still farmed in our study site, had also worked at a local level in conservation agencies for several decades and was referenced as a respected local leader by several other interviewees. Based on his experience working with conservation initiatives in and around our study site, this agent summed up the sentiments of many of our interviewees:

*That farmer to farmer contact...is so important... It’s hard for them to go out and replace a piece of equipment and totally change their practices... There’s a big learning curve there. But if you can get farmer to farmer or neighbor to neighbor talking and then to have the technical support from the government... [That is how] you put it onto their level where it means something to them, onto their land that they manage.*

**Institutional transparency**

When viewing photographs of perennial conservation practices, many farmers expressed strong and mixed emotions about the nature of government farm conservation programs. Four themes describe, from the perspectives of our interviewees, characteristics of conservation programs that would increase the success of perennial conservation practices: *consistency over time, straightforwardness, flexibility, and careful targeting.*

Twenty-seven of our interviewees expressed some sort of general suspicion of the government, while eight of the active farmers with whom we spoke volunteered that they were not fond of government commodity subsidies that rewarded corn and soybean production. One farmer’s comments echo the sentiments of other interviewees: “Well shoot,
I’d just as soon all my income came from the open market. Then I wouldn’t have to deal with the government at all. That would be the best thing ever.” On a pragmatic level, however, many farmer interviewees had worked with the complexities of the commodity subsidy programs for several years and spoke of these programs as a routine part of rural life.

Twenty-five of the farmers we interviewed favored a hypothetical transition to “green payments,” wherein farmers receive government support to implement restoration projects on marginal agricultural land. Yet 16 of these same farmers simultaneously admitted a hesitancy to express support for, and participate in, these green conservation programs due primarily to three factors. First, 10 farmers complained about the changing and ephemeral nature of government conservation programs. One farmer talked about these programs in this way: “I don’t see anything wrong with any of them... I just, after that 10 year program, I just don’t trust the government. You don’t know what they’ll do. They’ll flip-flop on you.” Second, 10 farmers mentioned the complexity and hassle of working with the conservation programs, and third, 14 farmers voiced a general resistance to regulation. Many of these interviewees advocated for greater flexibility in farm conservation programs so that they could be adapted the particularities of different farms and farming operations. One large corn, soybean, and hog producer wrestled with his feelings about government regulation in this way:

Well, ideally we’d get paid for stuff we’re doing without having to jump through all the hoops to do it. But... the guys that write the programs and come up with these ideas are in a tough spot. They’ve got to write it so they’re sure the people that deserve it are the ones that are getting it...you have to build in safeguards to protect against fraudulent application and fraudulent acceptance of payments that you really haven’t earned.

Two local leaders, one in conservation and the other in politics, were concerned about lack of funding for conservation programs. They emphasized the need to carefully target how limited conservation funds were spent and to direct dollars, personnel, and practices at critical locations across landscapes. Both saw agricultural and environmental technologies making this process more feasible in the future. One of these leaders put it this way:

I believe, and very firmly, that into the...very short future, conservation technicians are going to have to get extremely sharp about what they are doing—the technology is there—and not over-design things. Target, target, target. Don’t waste your money. Target it.
Discussion

*Stuck in a trap*

Our interview data revealed a discrepancy between what is desired and what is actually thought feasible in terms of current land use in the Corn Belt. Although most interviewees voiced tentative approval of more widespread distribution of perennial conservation practices on marginal agricultural land and of green payments to support these practices—the adoption of such practices is not currently a priority within this rural social-ecological system.

Diffusion of innovation theory helps us to explain why seemingly beneficial innovations are not adopted. Results of diffusion research indicate that the rate of adoption for an innovation is directly proportional to an that innovation’s relative advantage, compatibility, trialability, and observability, and inversely proportional to its complexity (Rogers 2003). Examples of these principles abound in our data. Although interviewees perceived perennial conservation practices as having some relative advantages over some current agricultural practices, they suggest that these practices exhibit low compatibility with their current farm priorities, profitability, practices, and technologies in comparison to growing more corn and soybeans. Perennial conservation practices may also have high initial implementation costs and are often long-term, making them difficult to adopt on a trial basis when compared to, for instance, trying a new variety of seed corn or fertilizer application.

In addition, as operators compete against one another for land to farm, they often find themselves paying high rent to the owners of the land and therefore make little profit per land unit. This increases the pressure on operators to farm more ground, which means that prompting the owners to put land in conservation programs is neither profitable nor a priority. Interview data also show how agribusiness corporations are heavily invested in the growth of row crop agriculture through franchises and salespersons that are well-integrated into local communities and social networks. In contrast, conservation agencies and personnel are only partially or weakly connected to these same communities and networks. Interviewees viewed conservation practices, and their attendant government support packages, as more complex and less reliable than growing corn and soybeans under current
commodity production incentive programs. This is in part because the structure of commodity programs has been largely consistent for several decades whereas conservation programs have changed a great deal over time.

These examples illustrate how adoption of perennial conservation practices is currently impeded within the Corn Belt social-ecological system at multiple scales (Fig. 3.2). Resilience theory suggests that systems rich in natural and external resources, such as the high input row crop systems found in the Corn Belt, can function in ways that appear optimum during periods of productivity and growth while simultaneously losing their ability to adapt to unforeseeable change and crisis. When an extremely rich system loses its dynamic character to respond to the normal adaptive cycles of growth, collapse, reorganization, and exploitation, it can become locked in a static configuration referred to as a rigidity trap (Gunderson and Holling 2002). Despite social and ecological dysfunction, systemic resilience to external perturbations can remain high, although its nature becomes more akin to a static engineered resilience than to dynamic ecological resilience.

Many aspects of the current Corn Belt system seem to be locked in just such a static trap. Despite decline in other social and ecological components of this system, agricultural growth continues to be reinforced by rich internal resources (including deep glacial soils, temperate climate, and social connectedness) as well as external inputs (including government commodity production subsidies, agribusiness investment in local community networks, energy from fossil fuels, nutrients, pesticides, herbicides, and agricultural technologies; Duffy 2006, Nassauer et al. 2007). While perennial conservation practices may be one tool to help restore ecological function to this system, social-cultural and political aspects of this system are not currently compatible with adoption of these practices.

Innovation across scales
Conservation practices are “preventative innovations” that often lack immediate profitability, but are adopted on the grounds that they will alleviate future problems (Rogers 2003). For this reason, their effects have a high degree of uncertainty and there has been debate—much of it centered in the Corn Belt—as to whether ‘classic’ diffusion theory can be applied to conservation innovations (Nowak 1983, van Es 1983, Fliegel and Korsching 2001). The
perspectives taken by scientists on both sides of the debate suggest that greater understanding of attendant political, social, and ecological context is crucial to understanding the adoption of preventative innovations.

Resilience theory suggests that feedback loops between social and ecological processes, acting at different spatial and temporal scales, can constrain or enhance the potential for innovation within the system. Interview data suggest that adoption of conservation practices is not contingent upon a simple or single factor such as economic profitability or effective government conservation legislation. Rather, landscape-scale adoption of perennial conservation practices must be compatible with ecological, socio-cultural, economic, and political aspects of Corn Belt systems at multiple scales.

Analysis of our interview data leads us to posit that farmer adoption of perennial conservation practices is contingent upon compatibility of these practices with other aspects of the system at three key scales (Fig. 3.2). At an individual/farm scale conservation practices must be compatible, not only with farm profitability, but also with current farm priorities, practices, and technologies. Our data also illustrate how interpersonal communication through relatively local social networks and normative cultural signals mediate the way in which our interviewees made decisions about their landscapes. The extent to which government programs are seen to be consistent, long-term, straightforward, and adaptable to their farm operations also has a great impact on whether or not farmers are actually willing to participate in these programs.

Because rural stakeholders view their environs primarily as a “countryside” network of farms and people (Chapter 2), the community “meso”-scale may play a particularly key role in the Corn Belt system in mediating interactions between macro and micro processes. Local conservation agents may be able to utilize community social networks to broker interactions between variables that have the potential to change in relatively short timeframes (such as infield land use practices) and variables that are slower to change (such as hydrologic function, rural culture and demographics, and national agricultural policy).
Linking adoption and adaptation

At the close of interviews, we asked interviewees to tell us what they would most like to see in the countryside of the future. While many of our respondents initially balked at the question—considering change unlikely or having trouble conceiving of a future that was different than the present—some went on to display a great deal of creativity in their answers. We consider their answers creative because they synthesized or elucidated concepts that were discussed earlier in the interview in new and unexpected ways. Having already viewed and discussed photos of Corn Belt landscapes—many of which depicted various perennial conservation practices—several of the creative futures envisioned by interviewees linked conservation practices to other aspects of the countryside that they had indicated were important to them at the beginning of interviews. For example, the operator of a large corn, soybean, and hog farm summarized what he considered to be the most important themes of our interview in this way:

*Number one, keep the farm families on the land. Number two, the technology that is coming is not going to get any smaller, it’s just going to keep booming, [pause] and I think that’s a positive. [pause] And the environmental side of it is not going to go away... You could draw arrows between these three and just make it a big circle, because the technology is going to help on the environmental side. The environmental side—the farm families want to keep the environment protected as much as they can because they’re out here, living in that area. And in order for the farm families to stay out here, they’re going to have to utilize the technology. Because if the farm family can’t be productive, then they’re going to have to get off farm jobs, which means they’re going to get pushed back to the city.*

For these reasons, we deem that creative integration of perennial conservation practices into ideal futures was based on a genuine process of social learning (Plummer and FitzGibbon 2007) though interviews. Some of the strongest positive comments about conservation practices came only after interviewees had had time to consider and talk through the connections between these innovative practices and other aspects of the systems in which they lived. Our interview data indicates that future adoption of perennial conservation practices will not hinge upon a simple economic, political, or technocratic fix at any one scale of the system, but rather on collective adaptation of social actors across multiple scales and through collaborative learning.
Conclusion
Corn Belt social-ecological systems are currently trapped in a static configuration by the convergence of factors across several scales. These factors make system change—including the increase of perennial cover on the landscape—difficult. However, the emerging bio-economy ushers in a time of reorganization and uncertainty, creating potential for long-term change in key system structures. Successful adoption of perennial conservation practices depends upon adaptation of socio-cultural and political structures at multiple scales within Corn Belt systems; initiatives that focus on optimization of outcomes at only one scale are not likely to result in widespread adoption or in long-term and lasting change. The scales that seem to be limiting in this system are highly social in nature and include cultural, as well as spatial and temporal, components. In particular, the community scale arose repeatedly in our data as playing an important role in mediating the interactions between individual decisions on private property and regional outcomes encouraged by government incentives and regulations. Our research suggests that an increase in the interpersonal contact between conservation agents and potential adopters of conservation practices may play a key role in brokering information across scales and in bridging differences in perception. Such collaborative learning has the potential to harness the adaptive capacity of regional social actors and to bolster the ecological resilience of Corn Belt agricultural systems.

Literature Cited


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Table 3.1. Characteristics of Hamilton County as compared to the average of all fifteen Iowa counties located entirely or nearly entirely within the Des Moines Lobe geologic formation (USDA NASS 2002, EWG 2006).

<table>
<thead>
<tr>
<th>Characteristic (values for 2002 unless noted)</th>
<th>Hamilton County</th>
<th>DSM Lobe Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hectares (ha)</td>
<td>149,365</td>
<td>145,949</td>
</tr>
<tr>
<td>Percent of total land in farms</td>
<td>94%</td>
<td>95%</td>
</tr>
<tr>
<td>Percent cropland</td>
<td>89%</td>
<td>88%</td>
</tr>
<tr>
<td>Percent land in harvested corn and soybeans</td>
<td>84%</td>
<td>82%</td>
</tr>
<tr>
<td>Percent land in perennial cover types</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Percent land in govt. conservation programs</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Cattle and calves sold (number)</td>
<td>5,701</td>
<td>16,564</td>
</tr>
<tr>
<td>Hogs and pigs sold (number)</td>
<td>1,270,158</td>
<td>556,630</td>
</tr>
<tr>
<td>Average size of farm (ha)</td>
<td>177</td>
<td>175</td>
</tr>
<tr>
<td>Median size of farm (ha)</td>
<td>96</td>
<td>107</td>
</tr>
<tr>
<td>Farms (number)</td>
<td>797</td>
<td>790</td>
</tr>
<tr>
<td>Corn and soybean subsidies 2005 (U.S. $)</td>
<td>26,582,426</td>
<td>24,581,155</td>
</tr>
<tr>
<td>Conservation Subsidies 2005 (U.S. $)</td>
<td>1,913,244</td>
<td>1,619,051</td>
</tr>
</tbody>
</table>

Table 3.2. The twelve themes that arose from our interview data arranged into three classes: farm compatibility, community reinforcement, and institutional transparency.

<table>
<thead>
<tr>
<th>Farm Compatibility</th>
<th>Community Reinforcement</th>
<th>Institutional Transparency</th>
</tr>
</thead>
<tbody>
<tr>
<td>New practices must be compatible with farm:</td>
<td>Decisions to adopt practices are reinforced through:</td>
<td>Practices must be supported by programs and policies that are:</td>
</tr>
<tr>
<td>Priorities</td>
<td>Face to face communication</td>
<td>Consistent over time</td>
</tr>
<tr>
<td>Profitability</td>
<td>Local social networks</td>
<td>Straightforward</td>
</tr>
<tr>
<td>Practices</td>
<td>Cultural social norms</td>
<td>Flexible</td>
</tr>
<tr>
<td>Equipment and Technology</td>
<td>Local support structures</td>
<td>Carefully targeted</td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fig. 3.1. Our study site is a rural agricultural community situated in the middle of the Des Moines Lobe eco-region in southwest Hamilton County, Iowa, USA.
Fig. 3.2. Analysis of interview data reveals correspondence between three key biophysical scales and overlapping social scales (Chapter 2). Corn Belt social-ecological systems are configured at multiple-scales with strong infrastructure to support increased row-crop production, while providing only a fraction of the comparable support for conservation practices. Analysis of our interviewees’ responses shows that successful diffusion of perennial conservation practices must consider the social-ecological context surrounding practices at multiple scales including: consistent, straightforward, targeted incentives and regulations; reinforcement through social networks, norms, and support structures; and compatibility with farm priorities, profitability, practices, and technologies. These are many of the same factors that are currently arranged to support increased row crop production of corn and soybeans.
CHAPTER 4:
HOW TO BUILD MULTIFUNCTIONAL AGRICULTURAL LANDSCAPES
IN THE U.S. CORN BELT: ADD PERENNIALS AND PARTNERSHIPS

A manuscript to be submitted to Society and Natural Resources

Ryan Atwell, Lisa Schulte, and Lynne Westphal

Abstract

Conservation of biodiversity and ecosystem services in agricultural regions worldwide is foundational to, but often perceived to be in competition with, other societal outcomes, including food and energy production and thriving rural communities. To address this tension in the U.S. Corn Belt, we engaged leaders from agricultural, conservation, and policy arenas in Iowa, USA in a participatory workshop to determine constraints and leverage points for broad-scale implementation of perennial practices aimed at bolstering ecosystem services in agricultural landscapes. Qualitative analysis of workshop data highlights the complexity involved in achieving multi-objective societal outcomes across privately-owned, working landscapes—especially as the region enters a period of rapid reorganization driven by the demand for bioenergy crops. Initiatives that focus on perennials are seen as having potential to span differences between conservation and agricultural interests. However, their success is dependent upon building policy mechanisms that (1) integrate working lands and protected areas, and (2) link local creativity and initiative with regional vision, support, and accountability. This can be accomplished by strengthening markets and offering competitive grants that give value to desired outcomes while holding multi-level partners accountable for landscape planning and measurable watershed-level results. These mechanisms are dependent upon strategic collaboration between diverse partners, and must be facilitated by vertical and horizontal forms of social capital within and between actors and institutions operating at different levels of the system.
Introduction

New crop markets associated with the production of biofuel stocks are driving land-use change in agro-ecosystems worldwide, raising environmental concerns about land clearing, biodiversity, and carbon debt, as well as social concerns about competition between food and fuel (Fargione et al. 2008, Field et al. 2008, Groom et al. 2008). Maintenance of biodiversity, ecosystem services, and other societal goods in the midst of this period of reorganization is dependent upon responsive policies that mediate the drivers and outcomes of land use at broad landscape scales. Because arable agricultural landscapes are often privately owned and operated, landscape-scale change is the product of an amalgamation of decisions by individual actors which are in turn influenced by local social norms and networks, and macro-level markets, technologies, and policies (Chapter 3; McCown 2005).

Development of policies that bridge these micro- and macro-level forces to protect landscape-scale outcomes is a recognized challenge in agricultural regions (Mattison and Norris 2005, McCown 2005).

Resilience theory is an emerging approach to understanding and influencing such processes of change in complex natural resource management systems (Gunderson and Holling 2002, Folke et al. 2004, Walker et al. 2006). While it can be helpful to define and analyze ecological and social systems separately, resilience theorists use the term social-ecological systems to emphasize that they are in fact linked and that such delineation is artificial and arbitrary (Berkes et al. 2003). This framework has received widespread attention and application among scientists and practitioners from diverse fields (Carpenter and Folke 2006, Liu et al. 2007), but has not been widely implemented in regions dominated by intensive agricultural production and autonomous private property rights such as the U.S. Corn Belt. The term “resilience” was applied to ecological systems by Holling (1973) and refers to the ability of dynamic systems to respond to perturbations and maintain their essential configuration. Resilience is a non-normative term; system configurations characterized as resilient may be either desirable or undesirable. In particular, resilience theorists are interested in understanding where resilience, adaptive capacity, and the potential for innovation reside in linked social-ecological systems and how these attributes can be gained, lost, or preserved. Because human values, perspectives, and collective decisions are
fundamental in determining the structure, function, and desirability of social-ecological systems, resilience analyses emphasize the integration of stakeholders and policy makers in scientific and decision-making processes (Walker et al. 2002). Although resilience theory emphasizes the importance of social actors in determining the trajectory of linked social-ecological systems, it has received criticism for inadequate application of social theory and for oversimplifying complex problems in order to incorporate social phenomenon as quantifiable “variables” in systems “models” (Harrison 2003).

Much of the research using resilience theory has investigated how institutions and policies can bolster desired characteristics in regions with focal common pool resources and/or less autonomous private property rights; for example, in developing nations (Lejano et al. 2007), fisheries (Olsson et al. 2004, Armitage et al. 2007), or regions with high proportions of government owned land or collectively-managed resources (Berkes et al. 2003, Lebel et al. 2006). One study which analyzed resilience in the Western Australian Wheat Belt, a region dominated by private land ownership and high agricultural production, found that the land-use decisions of farmers were collectively driven by macro scale markets, technologies, and institutions, with little consideration of regional factors such as population decline, environmental pollution, and resource depletion (Allison and Hobbs 2004, 2006). This resulted in a resilient, but undesirable, system configuration maintained by highly-connected institutions and policies which were focused on facilitating commodity production. Few mechanisms that could leverage change in response to regional social and ecological decline existed in the system. For instance, rising water tables and salinization, driven by land clearing for agriculture, have led to irreversible resource degradation (including lack of crop production) on upwards of 16% of the region’s cropland. But because of the high degree of “sunk costs” invested in the current system trajectory, few options for change are perceived. Irreversible resource degradation on certain lands, coupled with decreased crop prices, higher input costs, and lower farmer profit margin, lead to increased demand for production on other lands.

In comparison to the Western Australia Wheat Belt, agricultural production systems in the U.S. Corn Belt are shaped by parallel macro-level markets, technologies, and policies aimed at boosting commodity production, and are experiencing similarly complex social and
ecological challenges (EWG 2006, Keeney and Kemp 2002). From 1950 to 2002, the portion of agricultural revenue returned to farmers decreased from 37% to 19%, while farm input costs increased sevenfold and the real price of corn (adjusted for inflation) decreased fivefold (Duffy 2006). Such changes in farm profitability are linked to consolidation of land holdings into fewer larger farms, more land devoted to row crop production, rural emigration, increase in farmer age, and a decrease in rural population, numbers of young farmers, and social vitality (USDA NASS 2002, Duffy 2006). Regional increase in row crop production and loss of land in perennial cover has been associated with decline in biodiversity (Best et al. 1995) and flood control (Sand 2008), and implicated as the primary driver of nitrate export from the region’s rivers (Hatfield et al. 2008), which in turn underlies the growing hypoxic dead zone in the Gulf of Mexico (EPA Science Advisory Board 2007). In 2005 the federal government spent over 2.2 billion US dollars on agricultural support programs in the state of Iowa alone. Nearly 40% of the income of regional corn and soybean farms comes from government payments, however, much of this funding is focused on boosting commodity production and benefits “absentee” farm owners rather than local operators or rural communities (EWG 2006, Keeney and Kemp 2002, Duffy 2006).

Despite these social and ecological deficits, and in contrast to the commodity production system in Western Australia, Corn Belt agroecosystems remain highly efficient at producing commodity crops and their derivatives. Corn and soybean yields have continued to increase over the last fifty years despite market consolidation and reorganization, dramatic changes in land tenure, pest outbreaks, and climactic variation (Duffy 2006). This resilience in regional commodity production is a result of the Corn Belt’s amenable biophysical setting, which include a temperate climate and deep glacial soils. It also possesses a highly connected socioeconomic system, bolstered by large-scale equipment and practices, hybrid and genetically modified seed technologies, and external inputs of fertilizers, pesticides, herbicides, and government subsidies. Unlike the Western Australia Wheat Belt, the U.S. Corn Belt appears to be stuck in a trap (Chapter 3; Gunderson and Holling 2002, Allison and Hobbs 2004) in which the high adaptive potential and connectedness of social actors makes it possible to continue to invest in the current way of doing agriculture, in spite of the mounting social and ecological deficits associated with this trajectory.
Currently, the amount of land taken out of production for conservation purposes (e.g., land enrolled in the Conservation Reserve Program) in the Corn Belt is decreasing and land in row crops is increasing in response to markets for corn based ethanol (Secchi et al. 2008). Despite continued regional investment in high-yield commodity production, recent research shows that Corn Belt residents are increasingly concerned about the impacts of the emerging bioenergy economy on the environment, natural resources, and the long term sustainability of rural landscapes (Hinkamp et al. 2007). One strategy to bolster social and ecological resilience of the Corn Belt system while maintaining agricultural profitability involves implementing networks of perennial vegetation across key portions of the landscape. Initial research suggests that strategically positioned perennial land cover on disproportionately small areas of the Corn Belt landscape (e.g., diverse crop rotations, pasture, riparian buffers, restored wetlands) has the potential to bolster regional water quality, biodiversity, and aesthetics (Schulte et al. 2006, Nassauer et al. 2007b, Schulte et al. 2008). While rural Corn Belt stakeholders voice tentative approval of some perennial conservation practices (Chapter 2; Nassauer et al. 2007b), these practices are neither well integrated into rural culture (Chapter 2), nor supported by regional policies or production systems (Chapter 3), and rural people voiced little sense of efficacy to bring about broad-based change in their landscapes or institutions (Chapter 2).

To address these challenges, we engaged Corn Belt leaders in agriculture, environment, and policy in a participatory workshop with the following objectives: (1) understand sources of adaptive capacity, innovation, and resilience in Corn Belt social-ecological systems, including the policy potential for perennial conservation practices, and (2) identify key roadblocks and leverage points (Meadows 1999) to maintain biodiversity, ecosystem services, and societal goods in the midst of the emerging bioeconomy. Because of its participatory nature, this research has the potential to impact regional policy and provide insights into the unique challenges faced globally in conservation across privately-owned, agricultural landscapes.
Methods
Our research was conducted in Iowa, U.S.A., a state situated in the center of the Corn Belt and the only state that lies entirely within this agroecoregion. While Iowa contains several distinct geological formations supporting diverse native habitats (e.g., prairies, wetlands, savannas, and woodlands), 90% of its land area now lies in farms and 63% lies in row crop corn and soybeans (USDA NASS 2002). Agricultural practices in Iowa are representative of those across the Corn Belt as a whole.

Using strategic sampling (Neuman 2003) and assistance from agency and non-profit partners, we selected key leaders in agriculture, environment, and policy in the state of Iowa as workshop participants. These leaders encompassed the breadth of perspectives that influence state-level land-use decisions, and they each held positions of influence in groups that play pivotal roles in these decisions (Table 4.1). Participants were also selected because each had demonstrated a personal ability to engage in thoughtful, creative, and constructive dialogue. Sixteen of the 17 leaders invited agreed to participate, but two state senators were unable to attend the workshop due to an extended committee meeting. The remaining 14 invitees participated in the workshop.

Two of these leaders were women; twelve were men. Participants ranged in age from 28 to 62, with an average age of 50. Thirteen had graduated from four-year universities and seven held graduate degrees. On average, workshop invitees had been working on agricultural or conservation policy issues for 24 years. Ten of these leaders had spent time farming and six currently owned and operated farmland. Eleven had lived in rural areas for at least 18 years or more.

Upon arrival, participants filled out a questionnaire that probed individual perspectives on agricultural land use change. A brief presentation was given to provide background and a common starting point. This presentation highlighted the results of a companion study investigating the perspectives of rural Iowa stakeholders on land use change and perennial conservation strategies (Chapters 2 and 3). Following this presentation, we facilitated a dialogue centered on three questions related to current and future land use, institutions, and policies in Iowa (Table 4.2). We also brainstormed creative alternative strategies to realize future goals, as reported in Chapter 5. The discussion lasted for two and
a half hours, during which we routinely encouraged participants toward creativity, vision, frankness, and the inclusion of diverse perspectives. The workshop closed with an opportunity for each participant to share final comments and observations.

The discussion was recorded using audio and visual media, but anonymity of participants’ comments in research reports was guaranteed to foster a candid dialogue. A transcript of workshop proceedings was imported into the NVivo7 data management and analysis software package (QSR 2006). The lead author then coded interview data into descriptive and analytic categories (i.e., themes) using a qualitative approach (Neuman 2003). All authors were present at the workshop and worked together to probe the strength, connectedness, and nuances of these themes and to ensure that analysis was consistent, valid, and confirmable.

**Results**

Analysis of workshop data shows that regional leaders from diverse agricultural and conservation perspectives exhibited thoughtful consideration of, and enthusiasm towards, strategies that use spatially-targeted perennial practices to achieve ecological and social outcomes in the midst of the emerging bioeconomy. Ten themes emerged through data analysis that summarize the most consistently- and strongly-voiced dimensions of this dialogue (Table 4.3). Three of these themes describe challenges to effective initiatives, while seven describe potential leverage points to reconfigure Corn Belt systems.

*Challenges: Dealing with complexity*

Our workshop participants emphasized that the complexity of the Corn Belt system was the most recognized challenge to implementing perennial practices. In the words of one participant: “We have an incredibly incomplete understanding of systems. And that gets in our way all the time.” This complexity took several forms.

Maintenance of ecosystem services was seen as defying simple solutions, and the scientific understanding of ecological systems was seen as limited, especially at broad spatial and temporal scales. But when our participants referred to “systems,” they were also referring to interactions between ecological and other system components (e.g., cultural,
economic, political, social). They perceived that managing these disparate system components to produce congruent outcomes was extremely difficult given the discrepancies in their different modes of operation, methods of analysis, and units of measurement. Key questions that workshop participants wanted answers to included: (1) could economic markets be built that reflected the value of desired ecosystem services and social goods? and (2) how could the impact of key partnerships between diverse stakeholders groups be efficiently facilitated, monitored, and summarized and built into future policies?

Workshop participants also indicated that the playing field involved in natural resource management was constantly changing. The capacity for drastic and unexpected change in the system was seen as particularly powerful in the context of the biofuels boom. Other participants spoke of changes in rural demographics including an increase in absentee land owners, the increasing age of farm operators, and the unraveling of rural infrastructure, economies, and social networks. All of these changes were seen as dramatically impacting rural systems, but their ramifications were difficult to predict, much less manage.

Workshop participants expressed multiple views on the ultimate objective of perennial practices that were implemented for conservation purposes, including improving surface water quality, biodiversity, soil health, carbon sequestration, marketable cropping systems, rural aesthetics, recreational opportunities, and rural social vitality. The need to build policy to address these multi-objective outcomes was recognized. Such initiatives were seen as different from past programs that focused on only one outcome (e.g., soil conservation). It was recognized that attempts to achieve multiple objectives simultaneously further increased the complexity of initiatives. When addressing this multiplicative complexity, robust science was viewed as a critical component of the systems approach advocated by participants, but the incorporation of multiple stakeholder perspectives (e.g., farm owners and operators, rural residents, agricultural and conservation interest groups) was of at least equal importance.

**Leverage points: bridging system boundaries**

Regional leaders indicated that the potential for initiatives to overcome limited understanding and achieve multi-objective outcomes in changing systems hinged upon the ability to link
key components that often exhibited disconnect in current system configurations. One of the bridges most strongly emphasized by stakeholders was integrating conservation of protected areas and working landscapes. Participants emphasized that, in the current system, government financial incentives to keep agricultural land out of production as part of conservation programs could not compete with the rising value of crops for bioenergy feedstocks. To be broadly implemented, perennial practices had to be able to generate value, including economic sustainability for rural stakeholders and communities.

Twelve participants gave examples of current or potential approaches that would blur distinctions between protected conservation areas and working lands. This included increasing use of the countryside by wildlife, recreation, and tourism industries; pasture and grazing as ecological management tools; and investment in alternative biofuel stocks such as diverse prairie and woody crops. Several of the ideas proposed emphasized recognizing, utilizing, and/or transforming extant aspects of the current system to encourage multiple uses of land for both agricultural and conservation benefit. For instance, riparian buffers and highly erodible land could be planted to a diverse forage mixture which could generate economic value through rotational grazing, harvest for perennial biomass, hunting rights, or carbon credits.

Although adding value to desirable perennial practices was an important first step, workshop participants indicated that landscape planning was also a necessary complement. Such planning was seen as essential in overcoming the lack of societal benefits associated with programs and practices that focused on individually owned or operated farms. Workshop dialogue between regional leaders on how to best span private property boundaries and coordinate management over landscapes highlighted the need for another important link in the system: local creativity and initiative must be empowered by regional goals, support, monitoring, and accountability. When asked what strategies were currently working to meet multi-objective conservation goals in Iowa agroecosystems, the first response characterized much of the subsequent discussion: “I think some of the best examples of things that are working well are pretty localized.” That successful strategies were driven to a large extent by local initiative was a theme voiced by nine workshop participants with no disagreement (but with the caveats of partnership and accountability
discussed below). The participant quoted above went on to explain a widely agreed upon assertion: that conservation initiatives were successful when local “stake,” or ownership, was coupled with careful planning by a consortium of key interests.

Empowering local initiatives was voiced as important for several reasons. Creative and novel solutions were seen as arising out of grassroots efforts because local people had an intimate knowledge of the systems in which they lived and worked. It was also pointed out that outside control was oftentimes resisted when groups felt that external entities were pressing private individuals to provide public goods, while not providing adequate compensation for them to do so. External control was associated with bureaucratic inefficiencies, lack of attendant local benefits, and little understanding of and appreciation for the values and realities that underlie local livelihoods.

Local control was not, however, viewed as a panacea; strong institutions were seen as its necessary complement. Our workshop participants emphasized that local control must include careful planning, organization, and empowerment across and between multiple organizational levels. Twelve participants emphasized the need for regional institutions to augment local initiatives in several ways including scientific monitoring, financial support, technical support, and collective goals and vision. Block grants that provided funding to local watershed groups of farm owners and operators to meet measurable outcomes in water quality in a manner of their own choosing were among the mechanisms suggested.

Building a sense of shared understanding, stake, experience, and rapport between diverse partners at multiple levels of the system was seen as essential for achieving outcomes. Eleven workshop participants described successful partnerships between diverse entities such as land owners, farm operators, neighbors, community and watershed groups, non-profit organizations, agriculture and conservation coalitions, scientists, industries, government agencies, and policy makers. These partnerships were both horizontal (between other entities operating at similar scales and power structures) and vertical (between entities at different scales or different levels of power) in character. An example given of a horizontal partnership included a watershed coalition of farmers and landowners surrounding a lake. Vertical dimensions were added to this localized effort when (1) the group used social norms to encourage other individual land owners and operators to change practices, (2)
a state non-profit organization and a federal agency provided technical assistance, and (3) the group applied for and was awarded state and federal grants. In another instance, an agriculture group, a conservation group, and an academic research center had partnered to pool their diverse resources and connections to catalyze and empower a watershed conservation planning effort. These partners, in turn, built connections with local land owners and farm operators as well as with federal and state agencies.

**Discussion**

Results show that implementing perennial practices at landscape scales to achieve societal goals has broad appeal to Corn Belt leaders from diverse agricultural, conservation, and political backgrounds. The appeal of perennials lies in the potential of these practices to achieve multi-objective outcomes while blurring the distinction between working lands and protected areas (Fig. 4.1). Such an approach, focused on building market value into agroecosystem strategies that achieve desired multi-objective outcomes, is ideally suited to privately-owned landscapes. In these landscapes, large protected areas are unrealistic; ecosystem services and other societal goods must be achieved through landscape-scale planning within working lands and across private property boundaries. But building a system to market a new crop, or to achieve coordinated landscape change among several users in a watershed, requires coordinating initiatives between social actors who operate at different levels of the system, who are themselves changing and who have subtly different goals and visions.

Past conservation initiatives in the Corn Belt have been primarily focused at the scale of individual farms, fields, and patches, and on single-objective outcomes such as removing highly erodible land from production, building soil by reducing tillage, or resting land to reduce supply and increase crop prices (Secchi et al. 2008). Multi-objective initiatives that overcome private property boundaries and build landscape networks of perennial conservation practices represent a new paradigm in conservation practice, and as such, pose unique challenges that must be overcome (Kraft 2008). The rural stakeholders who make land use decisions value independence, are often suspicious of government regulations and programs, initially balk at conservation strategies that threaten to restrict infield agricultural
practices, express land ethics focused on smaller farm and field scales, and display little ownership of, or feelings of efficacy to change, regional institutions (Chapter 2). Past conservation objectives have often had similarly narrow vision, focusing on understanding and protecting key focal species or seemingly isolated parks and preserves (McCormick 2003).

While initiatives that focus on perennials have the potential to link agricultural and conservation objectives, the workshop participants indicated that there are no regionally comprehensive policy fixes that can mandate or coerce perennial landscape change on broad scales. While top-down regulations and incentives are one part of complex solutions, conservation initiatives that span private property boundaries necessitate working with a host of diverse decision-making agents at multiple levels of the system- farm owners and operators, conservation support personnel and regional agency, non-profit, industry, and policy leaders. Many of the leverage points where leaders identify change happening are the product of key relationships between particular individuals and institutions in a given locale. Because of their particularity, these relationships are often difficult to summarize in an objective manner or reproduce at other system loci; but they are nonetheless key to desired system change.

Westley et al. (2006) investigate the process by which social innovation happens in complex systems that are resistant to change. They point out the human tendency to treat complex systems like machines, but suggest that such an approach, focused on understanding a whole as the sum of its interacting parts, is limited because it ignores the living, relational aspects of these systems. They show how seemingly unlikely changes in complex systems often come about when social actors, who are intimately involved in the system, come to understand system relationships through first hand experience which gives insight into how to produce innovation among its members. The “lived” knowledge of these social innovators allows them to see and understand the dynamic “rules of engagement” and “strange attractors” that govern the system and they understand how to work with and through these interactions to produce change. Although the interactional rules of engagement that govern complex systems are often reduced to a few simple principles once they are revealed, the knowledge to change systems can seldom be gained wholly through external, objective
predictive tools. For this reason, Carolan (2006) argues that when addressing natural resource management dilemmas, the knowledge contributions of scientists and stakeholders must be augmented by “interactional expertise” that understands and facilitates the necessary interactions between contributors.

Interactions between members is one key component of the human ability to adapt systems to increase the resilience of desired outcomes. In a manner that is similar to, but also different from, the way that living components of ecological systems adapt to their contexts over evolutionary time frames, human social actors have the capacity to adapt, through social learning, to the systems of which they are a part over timeframes that are several orders of magnitude faster than their non-human counterparts (Gould 1996, Westley et al. 2002). Especially when coupled with resultant advances in technology, this relatively fast-paced adaptation gives humans substantial power to diminish or bolster resilience of their systems. Our workshop participants were advocates of flexible initiatives that catalyze the adaptive capacity of relationships and partnerships among diverse social actors living in particular locales within the Corn Belt system. However, human actors seldom have the foresight to fully understand how their interventions impact components of the ecological system, which often change slowly and are subject to non-linear feedback loops and unpredictable thresholds (Gunderson and Holling 2002, Liu et al. 2007). As a result, social actors are often poor at discerning and responding to ecological indicators in a timely manner. Our workshop participants also indicated that, while it is important to give local partners the freedom and initiative to address dynamic problems in the way that they see fit, scientific monitoring and accountability to regional outcomes are also essential to build sensitivity to long term ecological change.

This interplay between local creativity and initiative and institutional empowerment and accountability has been widely recognized and studied in the management of common pool resources (Berkes et al. 2003, Armitage et al. 2007). In common pool systems, public access to natural resources must be managed by regulatory institutions to ensure their long-term sustainability. However, social actors at different levels of the system often have very different visions of what needs to be sustained and how to sustain it (Lebel et al. 2006). There are many examples of how uncoordinated use degrades a resource, or how a regionally
valuable natural resource is protected in a manner that handicaps the livelihood and alters the
culture of a local people group (Berkes et al. 2003, Armitage et al. 2007). It is suggested that
collaborative structures of governance must be built in order to manage resources in ways
that are responsive to changing science, technologies, markets, but also sensitive to the
livelihoods and cultures of local people.

Comparatively, in privately owned, high production agricultural landscapes, it may
appear that farm owners and operators who make independent decisions across large portions
of land have control over their own livelihood in a way that the users of common pool
resources do not. Yet, privately owned farms in the Corn Belt increasingly face pressures
similar to those described in the management of common pool resources. Land in the Corn
Belt is increasingly owned by non-local entities, and operators of large farms often borrow
heavily against the next year’s crop and generate little profit per land unit farmed due to high
input costs and other top-down influences over which they have little control (Chapter 2;
Duffy 2006). As in the privately-owned Western Australia agricultural system described in
the introduction, technologies, markets, and government subsidies severely limit the
autonomy of local farmers. However, where macro-scale forces have locked the Western
Australia system into a configuration characterized by little potential for change (Allison and
Hobbs 2004), the same types of macro-level forces are propelling Corn Belt systems into a
period of change. Incorporating the insights of Corn Belt leaders in the process of analyzing
system resilience suggests that much of the regional adaptive capacity to deal with this period
of change in proactive ways lies in strategic collaboration (Nkhata et al. 2008) between
partners within and across levels of the system.

How are strategic collaborations built in such systems? Again echoing insights
gained in the study of common pool resource management (Berkes et al. 2003, Armitage et
al. 2007), regional leaders describe the interplay between multi-level partners and institutions
as being built upon mutual understanding, trust, and reciprocity and upon shared social
norms and networks between diverse players across multiple system levels. This emphasis
on building relationships and institutional structures across system levels is the focus of
Woolcock’s (1998) theory of social capital for international development. Defined by
Woolcock (1998) as, “information, trust, and norms of reciprocity inhering in one’s social
networks,” social capital has been recognized as a necessary ingredient in empowering diverse actors to overcome the “tragedy of the commons” so often experienced in the management of common pool resources (Ostrom and Ahn 2003, Pretty 2003, Plummer and FitzGibbon 2007). Woolcock (1998) proposes that many challenges in international development must be addressed by building social capital within and between community and institutional social scales.

The insights of our workshop participants, and the results of a companion study of rural Corn Belt stakeholders (Chapter 3), illuminate the ways in which the vertical and horizontal dimensions of social capital described by Woolcock (1998) influence relationships among diverse partners across multiple organizational scales to mediate social and ecological outcomes in the Corn Belt (Fig. 4.1). Rural stakeholders valued stewardship and social integration at community scales, but expressed little understanding of, or efficacy to effect change over, their regional landscapes or institutions (Chapter 2). Adoption of perennial conservation practices was also seen as dependent upon social norms and connectedness with institutional partners at community scales (Chapter 3). Regional leaders’ experience of what is working well in regional conservation initiatives corroborates the insights of stakeholders, but adds understanding of policy and institutional mechanisms. Their insights illustrate how policies and approaches that build social capital within and among individuals, communities, partners, agencies, and institutions are essential for the development of initiatives that realize conservation objectives across working landscapes (Fig. 4.1).

Where rural sociologists have emphasized the ways in which social capital and civil society within local Corn Belt communities are essential in achieving watershed outcomes (Flora et al. 2004, Morton In Press), the insights of our regional leaders suggest that these processes must also be facilitated within and among micro (e.g., farm owners and operators, community norms and networks, local agriculture and conservation personnel) and macro (e.g., state level agencies and non-profit organizations, agribusiness corporations, federal policies) levels of the system. In the present system, rural communities are no longer made up of, or influenced by, primarily local entities. Farm estates are divided between several children and grandchildren, increasing amounts of land are owned by corporate or urban investors, and operators rent farmland from as many as a dozen owners. Agricultural advice
offered through locally-employed agronomists is shaped by agribusiness corporations (Chapter 3). Federal farm programs and agencies influence how local farmers view conservation practices and constrain or enhance the effectiveness of local conservation personnel. In this complex, changing, and multilayered system, our workshop participants envision policies that foster novel approaches realized through collaboration between diverse entities. This collaboration might be facilitated by regulations that mandate measurable multi-objective outcomes from agricultural watersheds coupled with competitive funding to multi-level partners to meet objectives in manners appropriate to the characteristics and needs of local people and their land.

**Conclusion**

In the midst of system reorganization due to the emerging bioeconomy, perennial conservation initiatives, if implemented at landscape scales, are viewed by regional leaders in agriculture, the environment, and policy as having the potential to transform certain aspects of regional social-ecological systems into more desirable configurations. To address the complexity inherent in initiatives that span private property boundaries, policy mechanisms must build partnerships that blur distinctions between working lands and protected areas and bridge gaps between local creativity and initiative and regional support and accountability (Fig. 4.1). This can be done through competitive watershed improvement grants for multi-level partners, through landscape planning efforts that incorporate the perspectives of diverse stakeholders, and by strengthening markets for agricultural land uses that bolster ecosystem services and societal goods (e.g., carbon sequestration, biofuel from perennial biomass, rural aesthetics and recreation, and wildlife viewing and hunting). Success of these mechanisms is dependent upon creation of vertical and horizontal forms of social capital that facilitate strategic collaboration within and among social actors operating at different levels of the system. In the Corn Belt, much of the adaptive capacity to bolster ecosystem services and societal goods lies in this relational capital.
Literature Cited


QSR. 2006. NVivo7 (qualitative data management and analysis software). QSR International, Doncaster, Australia.


Table 4.1. Workshop participants represented the following entities.

Agricultural non-profit groups
   Iowa Farm Bureau
   Iowa Soybean Association
   Practical Farmers of Iowa
Business
   A regional farm management company
Conservation non-profit groups
   Iowa Natural Heritage Foundation
   The Nature Conservancy
Government
   Iowa Department of Natural Resources
   Iowa Department of Agriculture and Land Stewardship
   Iowa Department of Energy Independence
   U.S. Department of Agriculture, Natural Resource Conservation Service
   County Conservation Districts
Policy
   Iowa office of a U.S. Senator
   Independent policy analyst
Table 4.2. Workshop questions included the following.

1) Based on your experience, consider what policies, practices, and programs are working particularly well right now in the Corn Belt to bolster (a) water quality, (b) biodiversity, and (c) rural community vitality?

2) Corn Belt landscapes will change a great deal in the next decade in response to the emerging bioeconomy. What do you see as some of the key opportunities for (a) water quality, (b) biodiversity, and (c) rural community vitality?

3) What are the greatest roadblocks that may hinder (a) water quality, (b) biodiversity, and (c) rural community vitality?
**Table 4.3.** Major themes that arose from qualitative analysis of our workshop data, presented as either (a) challenges or (b) leverage points in the implementation of perennial conservation initiatives.

**a) Challenges: dealing with complexity**

<table>
<thead>
<tr>
<th>Theme:</th>
<th>Illustrative Quotation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited understanding</td>
<td><em>On water quality and non-point source [pollution] issues, we have a lot yet to learn. These are complex interactions… We have a new knowledge that has to be gained, and people have to be invested in [acquiring that knowledge]… We don’t have very good systems, especially when you start looking at them from three directions. We’ve got a few things that we can look at from one direction, but not very many from three.</em></td>
</tr>
<tr>
<td>Change and unpredictable thresholds</td>
<td><em>We have to create mechanisms that are flexible… We’ve had the same kind of scenario for the last dozens and dozens and dozens of years, and now it is all of a sudden upside down… We need things that can survive a landscape that we can’t even predict what it’s going to be.</em></td>
</tr>
<tr>
<td>Multi-objective outcomes</td>
<td><em>We’re looking at not only at water quality, but economic, community development, and also the biodiversity. And it’s because of who’s at the table that those issues remain important. So, you can capture strategies that are compatible, but it occurs when you are doing the planning. And you have to have pretty high capacity people to be able to develop a plan that provides multi-objective outcomes.</em></td>
</tr>
</tbody>
</table>
### b) Leverage points: bridging system boundaries

<table>
<thead>
<tr>
<th>Theme:</th>
<th>Illustrative Quotation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrating protected areas and working lands</td>
<td><em>We’ve got a political system that relies on philanthropy to support conservation right now… You have to unleash the economic activity of perennials; you can’t restrict all the economic activity on perennials… we’ve got an opportunity to maybe blur the interface between working lands and non-working lands. And I think there are some policy adjustments that we can make to do exactly that.</em></td>
</tr>
<tr>
<td>Build markets to create value</td>
<td><em>One of the challenges you have here is that if you can quantify and monetize a characteristic, you can get it. We’re developing a carbon market. And I would guess there’s a tipping point relative to [increasing] perennials [on the landscape] that is around thirty dollar [per acre for] carbon.</em></td>
</tr>
<tr>
<td>Landscape planning</td>
<td><em>We’ve had a proliferation of incentive programs without a demand for a corresponding kind of multi-farm or watershed planning. Since there hasn’t been a mandate for planning, the mandate is to spend the money with individual farms doing individual practices… That’s called “random acts of conservation.”</em></td>
</tr>
<tr>
<td>Local creativity and initiative</td>
<td><em>If you could cut through it all and say, “this watershed, we’re giving a block grant to… And we’re going to hold you accountable to some kind of outcome, but we’re not going to hold you to a specific program,” and let the creative juices flow. Let people solve this problem. We’re not allowing them to solve the problem because we’re saying you have to fit the tools that we’ve got; we have a limited tool box and some of them are broken.</em></td>
</tr>
</tbody>
</table>
### Institutional support and accountability

[Performance based incentives] are a good and a viable principle. I think the key of making performance-based incentives work, though, is good science and good metrics. Because to say, “let the local group decide what they want to do,” well that’s fine, but if it’s simply cosmetic or if it’s simply, “they’re kidding themselves,” then you really haven’t gained anything.

### High capacity partnerships

We’re talking about working across institutional levels, scales. Well, that system is already in place, with the [National Resource Conservation Service] and the [county level] Soil and Water [Conservation] Districts… There’s 400 and some county offices across the Mississippi River Basin, and I think we could do more to harness that system which is both locally led and a cooperation between the US citizens, taxpayers, and local farmers.

### Shared understanding and norms of reciprocity

Slip as close to the locals as possible. What scares me when I hear “let’s talk about [turning conservation set aside program into a working land program],” I’m terrorized, because I’m envisioning corn on all of it. And I know that’s not going to happen, [because] as we get down to the state I know you and you and you, and I trust you, and we can talk together and find multiple objectives. As you get down to the watershed it’s even better.
Fig. 4.1. In workshops, regional leaders developed strategies to deal with limited understanding, rapid change, and unpredictable thresholds in order to achieve multi-objective outcomes. They describe how Corn Belt policy initiatives should focus on creating institutional, economic, and cultural mechanisms that blur the distinction between protected areas and working lands and build social capital within and between multiple levels of the system.
CHAPTER 5:
TWEAK, ADAPT, OR TRANSFORM: POLICY SCENARIOS IN RESPONSE TO EMERGING BIO-ENERGY MARKETS IN THE U.S. CORN BELT

A manuscript to be submitted to Conservation Letters

Ryan Atwell, Lisa Schulte, and Lynne Westphal

Abstract
Emerging biofuel markets in the U.S. Corn Belt are leading to increased row crop production and removal of land from conservation programs. This comes at a time when regional research highlights the importance of perennial cover on key areas of the landscape to promote societal goods and ecosystem services. We engaged regional leaders in Iowa, USA in a participatory workshop to develop future policy scenarios that could guide Corn Belt land use in the midst of the emerging bioeconomy. Analysis of workshop data, in conjunction with the results of regional social and ecological research, was used to build a conceptual framework outlining interactions between key drivers and outcomes of regional agricultural land use. Three policy scenarios, also based on the insights of workshop participants, were overlaid upon this framework and included the following approaches: tweak, adaption, and transformation. Although these scenarios are all built upon the same scientific underpinnings, each describes a very different trajectory for Corn Belt social-ecological systems. Comparison of scenarios illustrates that, to achieve desired social and ecological outcomes, partnerships between diverse social actors who operate at different levels of the system are needed to mediate the effects of technology, markets, and policy on farmer land-use decisions.
Introduction

Bioenergy crops are often viewed as an environmentally beneficial alternative to global consumption of fossil fuel (Ragauskas et al. 2006). However, mounting research shows these cropping systems to have mixed environmental outcomes, and different biofuel stocks are associated with varying regional impacts on ecosystems worldwide (Fargione et al. 2008). In the U.S. Corn Belt, a recent spike in the demand for corn-based ethanol is currently leading to more land in row crops and less in perennial cover types (Secchi et al. 2008). This change in land use comes at a time when regional loss of perennial cover is increasingly implicated in declining biodiversity, water quality, flood control, and other ecosystem services (Best et al. 1995, Schulte et al. 2006, Hatfield et al. 2008). In particular, the export of agricultural nutrients (nitrogen and phosphorous) in Corn Belt river systems is implicated as a key driver of downstream hypoxia in the Gulf of Mexico (EPA Science Advisory Board 2007). Corn Belt stakeholders are concerned with how reorganization in agriculture associated with bioenergy production will impact the environment, natural resources, and long term sustainability of the state’s rural landscapes (Hinkamp et al. 2007).

System re-organization associated with emerging bioenergy markets, technologies, and crops will drive land use change in unexpected ways, presenting new challenges and opportunities for conservation. For example, initial research indicates that conservation strategies that integrate small, carefully targeted patches of perennial cover within Corn Belt agricultural landscapes (e.g., constructed wetlands, stream buffers, pasture, diverse cropping rotations, and certain biomass crops) can disproportionately benefit regionally-impaired ecosystem services (Schulte et al. 2006, Nassauer et al. 2007b, Schulte et al. 2008).

However, farm owners and operators do not view implementation of such practices as a priority, are reticent to make major changes in farming operations, and voice an inability to change the technologies, institutions, and policies that drive regional land use (Chapter 2). Both rural stakeholders (Chapter 3) and regional leaders (Chapter 4) indicate that successful implementation of perennial conservation initiatives is dependent upon policy mechanisms that address complex, scalar interactions within and between ecological and social drivers in the system.
To facilitate the development of such policy mechanisms, we integrated the results of research on ecological and social components of Corn Belt systems—including companion studies investigating how rural stakeholders perceive their landscapes and perennial conservation practices (Chapters 2 and 3)—with the insights of regional leaders from Iowa, USA in a participatory workshop to develop future policy scenarios. Our objectives were to (1) understand how scientists, rural stakeholders, and regional leaders viewed ecological and social drivers of land-use change in the Corn Belt, and (2) develop alternative policy scenarios that could bolster resilience of desirable system configurations. In particular, we probed how perennial conservation practices could promote ecosystem services and other societal goods in future Corn Belt landscapes. We do this using the framework provided by resilience science.

Resilience theory is an emerging approach to addressing complexity and change in linked social-ecological systems (Gunderson and Holling 2002, Folke 2005, Walker et al. 2006). “Resilience” refers to the ability of systems to respond to perturbations and maintain their essential configuration (Holling 1973). The goal of resilience analysis is to understand and bolster the resilience of desirable system configurations while avoiding those that are undesirable (Walker et al. 2002). This includes analyzing how social actors “adapt” to maintain systems in their present state, or “transform” systems into alternative states. Resilience science emphasizes the inclusion of multiple stakeholder groups in scientific and decision-making processes in order to understand a system from several angles. Specifically, scenario planning is a strategy that deals with uncertainty by developing a set of storied alternatives that describe a range of future system trajectories (Peterson et al. 2003a, Peterson et al. 2003b, Hulse et al. 2004). These alternative future scenarios are designed to be consistent with what is known about causal processes, but also to highlight how key decision points might influence system behavior under a range of assumptions and conditions.

Methods

Our research was conducted in Iowa, U.S.A., a state situated in the center of the Corn Belt and the only state that lies entirely within this agro-ecoregion. Agricultural practices in Iowa are representative of the intensive corn and soybean agriculture that predominate the Corn
Belt. Strategic sampling (Neuman 2003) and assistance from agency and non-profit partners were used to select key leaders in agriculture, environment, and policy in the state of Iowa as workshop participants. As a group, our participants encompassed the breadth of perspectives that influence state-level land-use decisions. Individually, they held positions of influence in organizations that played pivotal roles in state-level land use decisions (Table 5.1), and had a personal ability to engage in thoughtful, creative, and constructive dialogue. Sixteen of the 17 leaders whom we invited agreed to participate; two were unable to attend due to an extended legislative committee meeting. The remaining 14 invitees participated in the workshop. More detail on participant backgrounds and characteristics can be found in Chapter 4.

Upon arrival, participants filled out a questionnaire that probed individual perspectives on agricultural land-use change. In order to provide a common starting point, the workshop began with a brief presentation highlighting the results of a companion study exploring stakeholders’ perspectives on land use and perennial conservation strategies (Chapters 2 and 3) and outlining our research objectives. We then facilitated a dialogue on current and future land use, institutions, and policies in Iowa (Table 5.2). The discussion lasted for 2.5 hours, during which we routinely encouraged participants toward creativity, vision, frankness, and the inclusion of diverse perspectives. The workshop closed with an opportunity for each participant to share final comments and observations.

The discussion was recorded using audio and visual media, but anonymity of participants’ comments in research reports was guaranteed to foster a candid dialogue. A transcript of workshop proceedings was imported into the NVivo7 data management software package for analysis (QSR 2006). The lead author then coded this data into descriptive and topical categories (i.e., themes) using a qualitative approach (Neuman 2003). All authors were present at the workshop and worked together to probe the strength, connectedness, and nuances of themes on an iterative basis to ensure that analysis was consistent, valid, and confirmable.

In conjunction with the results of regional social and ecological research (Appendix 5.1), workshop themes (Chapter 4) were used to develop a conceptual model illustrating how
desired multi-objective regional outcomes hinge upon the interactions between key social and ecological variables. This model provided the underlying causal framework upon which future policy scenarios were built (Walker et al. 2002, Peterson et al. 2003b). The relationships described in this model were based on strong themes in our data and/or the results of regional research (Appendix 5.1). The unique narrative of each scenario was determined by using further qualitative analysis to compare and contrast workshop themes with resilience theory and the results of other regional research. Although these narratives reflect the creativity which we emphasized in facilitating the workshop, they are also grounded directly in the insights, ideas, comments, and concerns of workshop participants. Part of the qualitative analysis process involved searching for negative evidence in our data that would challenge or add caveat to primary themes; this negative evidence was also incorporated directly into scenario development. The relationship between the conceptual model and future scenarios was subject to iterative rounds of criticism, scrutiny, and development by the authors.

Results

The Corn Belt social-ecological system

The relationship between key drivers and outcomes in the Corn Belt social-ecological system are illustrated in a conceptual model (Fig. 5.1; Appendix 5.1). Key ecological components of this model—hydrology and perennial cover—have been radically altered in the Corn Belt through agricultural intensification. The region’s hydrologic structures are collectively-managed entities that have been altered over decadal timeframes through changes in technology, policy, institutions, and cultural norms. Underground networks of pipelines drain wetlands to increase cropping efficiency, while channelized streams create more land for crops and remove water from the landscape during wet seasons. However, these alterations in hydrologic structure also increase soil loss and flood severity, and deliver water-bound nutrients like nitrate nitrogen directly into regional waterways (Crumpton 2001, Schultz et al. 2004). The amount, position, type, and quality of perennial cover has been shown to impact regional biodiversity, water quality, and other ecosystem services (Schulte et al. 2006, Nassauer et al. 2007b, Schulte et al. 2008). Maintaining farm profitability, while
building soil quality, carbon sequestration, and biodiversity and controlling the loss of water and nutrients from the land, requires attention to the interaction between hydrology, the amount, type, position, and quality of perennial cover in agricultural landscapes. To achieve these outcomes, careful infield management is essential.

Because 90% of the land in the Corn Belt lies in privately owned and operated farms (USDA NASS 2002), the form and function of landscape-scale hydrological systems and vegetation patterns hinges upon the collective decisions and careful management of farm owners and operators. The decisions and land care practices of farm owners and operators are influenced by a host of factors including economic markets, farm profitability, changing rural social demographics, agricultural technologies, and federal farm policy (Chapters 2 and 3; McCown 2005). The interaction between community social norms and networks and regional institutions (e.g., government agencies, non-profit organizations, agricultural and environmental groups) can play a key role in mediating the influence of macro-scale markets, technologies, and policies on farmers’ land-use decisions (Chapter 4). Regional institutions may also have the capacity to influence the future direction of agricultural technology and federal farm policy. Corn Belt stakeholders emphasized that bolstering the vitality of the region’s struggling rural communities underwrites the potential for change in other aspects of the system (Chapter 2).

Scenarios
Analysis of workshop data revealed that regional leaders in agriculture, conservation, and policy approve of using perennial cover systems at strategic landscape positions to achieve multi-objective societal and ecosystem outcomes. Workshop participants explored a number of approaches to achieve these outcomes. These strategies generally fell into three categories, which we developed into alternative future policy scenarios: (1) tweak, (2) adapt, and (3) transform. The narrative of each scenario addresses how plausible, but uncertain, relationships between key system drivers can lead to different system outcomes (Figs. 5.2a-5.2c).
Scenario 1: tweak

You know, the amount of production we’re getting and the changes we’ve seen [in agriculture are pretty impressive]... Diversity is fine, but that’s an example of cause and effect changes that are so hard [to really understand]. It really is hard to get to diversity... We’re below... the renewable amount of soil loss in the state. And so maybe we’re doing pretty good.

The ethanol boom leads to a 10% increase in land planted in row crops, and changing markets and emerging technologies become the primary driver of land use. With world demand for energy and food increasing, Iowans take pride in the capacity of their farms for high production and industrial farming increasingly dominates the landscape. State legislation generally protects intensive agriculture from lawsuits filed by rural residents for more strict standards for clean air and water, except in a few watersheds characterized by high exurban development or lakes and rivers of regional importance. Populations of middle class farmers and young professionals continue to decline, and people increasingly leave rural areas and move to regional hubs. As aging farmers retire, the amount of land in large farms owned by outside investors increases and farms are increasingly operated by wage laborers.

As crop prices rise as a result of developing biofuel markets, government commodity subsidies are increasingly unpopular with urban voters, and the amount of federal assistance flowing into rural areas decreases. Climate change leads to an increase in the severity of storms, and federal disaster funds help offset crop and flood damage. As government conservation subsidies cannot keep up with rising crop prices, land is taken out of conservation set asides and converted to row crop production. It is recognized that some ecological sacrifices must be made across the majority of Iowa’s rural landscape in order to produce agricultural products; conservation initiatives focus on protection of areas outside of the agricultural mosaic, such as parks, lakes, and scenic river corridors. Many farmers choose to accept government payments that support the construction of wetlands and stream buffers on smaller portions of marginal agricultural land. These conservation practices are designed primarily to decreases soil loss and increase surface water quality, but are only marginally effective due to lack of funding for landscape scale planning and local technical support. The levels of pollutants in regional rivers remain high during rainy years, the
downstream Gulf of Mexico hypoxic zone continues to grow, and loss of grassland and prairie species continues.

**Scenario 2: adapt**

“We have to create mechanisms that are flexible enough to deal with the changing landscape... If you could cut through it all and say, ‘this watershed we’re giving a block grant to... And we’re going to hold you accountable to some kind of outcome, but we’re not going to hold you to a specific program,’ and let the creative juices flow. Let people solve this problem.”

Although demand for corn-based ethanol leads to a short term boom in crop prices, Iowa’s residents and leaders are increasingly concerned about instability in markets, the long term sustainability of the biofuel industry, and environmental deficits associated with increased crop production. Iowan’s increasingly demand multiple societal goods and ecosystem services from rural landscapes, including high production agricultural systems, water quality and reduced flooding, recreational and scenic value, wildlife habitat, and improvements in quality of life. Regional agriculture and conservation groups, government agencies, policy makers, and rural stakeholders collaborate to create initiatives that build local adaptive capacity to deal with changes in markets and technologies. Long-term vision is emphasized, and regional institutions work with agricultural industries to implement new agricultural production systems associated with bioenergy and bioproducts. While a certain segment of Iowa’s agricultural industry is expected to produce corn and soybeans, the future benefit of alternative forms of income from the natural resources of Iowa’s countryside is recognized.

As subsidies for commodity production become politically unpopular, Iowa groups lobby to keep federal funding flowing into the state by transitioning a substantial portion of this funding into programs that build rural communities and ecosystem services. Farm groups emphasize the economic opportunities for farmers associated with delivery of ecosystem services and link with conservation groups to lobby for tighter water quality standards. These initiatives are written into law, and Iowa environmental agencies begin widespread monitoring of nutrients and other agricultural pollutants discharged from underground field drainage systems and small order streams. The state takes a lead in watershed planning and monitoring and is able to leverage federal funding to offer competitive grants to farm owners and operators to meet these standards on a watershed
basis. Extra incentives are offered for the implementation of public access points, trail networks, and habitat for desirable species and species of conservation concern. Infield care is seen as essential to achieving landscape-scale benefits, and state and federal farm policy provides funding for technical support at the county level.

As a result of collaboration and landscape planning between diverse multi-level partners, agricultural provision of ecosystem services becomes a normative part of rural culture and Iowa’s countryside sees a marked increase in perennial cover. Regional farm and conservation groups join together to emphasize the societal and environmental benefits of grazing livestock on both productive land and conservation set asides. Networks of riparian buffers connect reconstructed wetlands that are built at the base of field drainage networks. As a result of landscape scale changes in hydrology and vegetative cover types, regional soil and water quality improve and biodiversity and desirable game species increases. The increasing variety of agricultural opportunities associated with new crop markets and systems, carbon sequestration, aesthetics, recreation, and provision of water quality lead to farms that are more diversified in size and production strategy. Iowa experiences a gradual increase in rural population, and corn and soybean production decreases as land in perennial biomass crops increases.

Scenario 3: transform

“I think you have to generate a vision that is compelling to all Iowa stakeholders... What would be exciting is an agricultural economy that is double what it is today... We're a supply-based agriculture; we take the price we get at the market place. But [what] if we created a thirty billion dollar a year [demand-based] ag[ricultural] economy in Iowa that considers energy, clean water, perennials, and multi-objective functions, and we could pay for it? That's something to get excited about.”

A group of regional leaders in agriculture, conservation, and policy are brought together by shared concern for the ongoing decline in Iowa’s rural communities and natural resources, and the questionable long-term sustainability of rowcrop agriculture and corn-based ethanol. These leaders also share a vision—that the emerging bioeconomy will usher in a period of rapid system reorganization during which there would be unique opportunities to fundamentally reshape Iowa’s agriculture and countryside. A goal is set: with assistance from their constituencies, these leaders will build agricultural markets that balance use and
conservation of Iowa’s deep soils, abundant water, unique habitats, and pastoral countryside. State and federal farm legislation sets high standards for environmental quality and funds partnerships between farmers, conservation agencies, non-profits, and industries to develop new strategies and technologies to meet these standards. Long-term funding for research and development rewards visionary approaches to redesigning agricultural production systems and landscapes.

Agricultural and environmental groups join with industry and academicians to develop perennial cropping systems that utilize and preserve of Iowa’s unique water, soil, and climactic patterns. Agronomists and natural resource professionals partner with farmers to target different cropping practices at key landscapes positions; each part of the landscape is seen as performing a valuable function based on its soils, topography, and hydrology. Wetlands come to be valued for their ability to purify the waste products of agricultural and other human uses. Types of algae are developed that can be grown in constructed wetlands to produce biodiesel. Local biodiesel is used in the trucks and trains that haul corn stover and perennial biomass to ethanol plants.

Cropping systems are designed to achieve ethanol production goals, while also providing water uptake, wildlife habitat, and aesthetic beauty during key times of the year. Hydrologic systems are reengineered to incorporate large buffers that allow streams to meander and slow the transport of water within the riparian corridor. Where the landscape permits, buffer edges are designed to create fields with long, straight borders that make farming with large equipment easier. These buffers and field areas with steep slopes are used for rotational grazing or for growing woody plants such as hazelnuts, hardwood trees for veneer and lumber, or poplar for ethanol. Dirt trails and public access points are installed alongside streams and wetlands, and bike trails are implemented through river corridors and field margins to connect small towns.

An aggressive marketing strategy, “ruraiowa.com,” is developed to attract young professionals from major population centers to the Iowa countryside. Driven by increased cost of living, pollution, and hustle and bustle in urban areas, and the capacity provided by the internet to work from remote locations, families from across the U.S. begin to relocate to rural Iowa. These people are enticed by affordable homes in small towns or to rural
homesteads where they can raise animals and plant a garden; hunt, fish, and watch wildlife in their backyard; know their neighbors; and participate in small town life. Federal and state partnerships offer increased assistance for young farmers, including programs that partner new farmers with retiring farmers and large or absentee land owners. While conflicts sometimes arise between different ways of valuing the landscape, the majority of farmers and non-farm rural residents grow to appreciate their interdependence and a common value set begins to emerge that focuses on preserving Iowa’s countryside and farming lifestyle. While vitality of some rural towns continues to decline, many others become important meeting places with thriving businesses and schools.

**Discussion/Implications**

The trajectories and outcomes of future Corn Belt social-ecological systems described by these scenarios vary markedly; yet, each is equally plausible based on the science and stakeholder perspectives that describe how components of the regional system interact. While the underlying system remains the same (Fig. 5.1), what varies across scenarios is the nature of the relationships between system components and the decisions made by social actors who operate at multiple scales to influence future outcomes (Fig. 5.2). Comparison of our scenarios suggest that, in tightly coupled social-ecological systems such as the Corn Belt, desirable multi-objective system outcomes hinge upon the collective intervention of regional social actors.

The scenarios described in this research advance the scientific understanding of complex Corn Belt social-ecological systems because they incorporate the understanding of actors who view the system from different scales and perspectives. The result is a set of relationships and possibilities not explored in their entirety by other, more limited, models that can provide focus for regional initiatives and research. Resilience theory suggests that, in tightly coupled socio-ecological systems such as the U.S. Corn Belt, one reason quantitative cause and effect models often fail to predict the actual outcomes of environmental problems is that human social actors adapt to alter the system in ways that are difficult to predict ahead of time (Gunderson and Holling 2002). Such human intervention can serve to maintain systems in their current configurations (e.g., wait and see);
interventions can also serve to adapt or transform systems into fundamentally new configurations.

Oftentimes, when social actors alter certain system components to optimize desirable outcomes, unrecognized feedback loops produce other unforeseen and undesirable outcomes (Gunderson and Holling 2002, Liu et al. 2007). These anthropogenic changes are difficult to forecast, in part, because actors who influence the system at different scales and view it from different perspectives each only have a few pieces of the complete puzzle, and/or value different system outcomes. In the Corn Belt, our workshop participants suggested that both agronomic initiatives focused on maximizing production to sustain farm profitability and conservation initiatives focused on land retirement to improve water quality and biodiversity have failed to achieve important societal outcomes. This is, in part, because these initiatives have lacked a systems perspective and failed to foresee the unintended impacts associated with optimization of focal system components on other important, but less recognized, outcomes (Secchi et al. 2008).

Our scenarios and their underlying conceptual model bolster understanding of links between social and ecological components of Corn Belt systems. They illustrate how dynamic relationships between regional institutions, community social norms and networks, and farm owner and operator decisions mediate the interaction between hydrology, perennial cover, and infield farmer care. If top-down factors such as markets, technologies, and federal farm policy are allowed to be the overriding drivers of farm owner and operator decision making, our scenarios suggest that Corn Belt landscapes will become highly efficient at row crop production at the cost of other desired outcomes (i.e., tweak; Fig. 5.2a). Scenarios demonstrate that these other outcomes will only come about if mechanisms to understand and bolster their function are built directly as central components of Corn Belt systems. Although the future is uncertain, the perspectives of regional scientists, stakeholders, and leaders suggest that adaptive or transformative landscape change to achieve desirable multi-objective outcomes is possible if a coordinated strategy of change is implemented across multiple levels of the system.
Literature Cited


QSR. 2006. NVivo7 (qualitative data management and analysis software). QSR International, Doncaster, Australia.


Table 5.1. Workshop participants represented the following entities.

Agricultural non-profit groups
   Iowa Farm Bureau
   Iowa Soybean Association
   Practical Farmers of Iowa

Business
   A regional farm management company

Conservation non-profit groups
   Iowa Natural Heritage Foundation
   The Nature Conservancy

Government
   Iowa Department of Natural Resources
   Iowa Department of Agriculture and Land Stewardship
   Iowa Department of Energy Independence
   U.S. Department of Agriculture, Natural Resource Conservation Service
   County Conservation Districts

Policy
   Iowa office of a U.S. Senator
   Independent policy analyst
Fig. 5.1. Analysis of workshop data, and the results of other regional studies, were used to develop this conceptual systems model highlighting how key drivers of Corn Belt land use influence desired regional outcomes (Appendix 5.1). Exogenous system drivers are macro-scale influences on the system that set the range of possible futures. Endogenous drivers are the key system components that vary across potential futures to influence the patterns and processes of future landscapes. Exogenous and endogenous drivers combine to influence multiple ecosystem services and societal goods, all of which are seen as important outcomes of rural landscapes. Focal relationships themselves influence or are influenced by other components of the system.
Fig. 5.2. Scenarios illustrate three possible future trajectories of Corn Belt systems: tweak (2a), adapt (2b), and transform (2c). These scenarios build on our simple conceptual model of the Corn Belt system (Fig. 5.1), and each highlights different aspects of this model. In “tweak” (2a), regional actors recognize the complexity of land use change, but resign themselves to the understanding that macro-scale forces beyond their control are driving the system. “Adapt” (2b), is focused on careful attention to complexity in order to build responsive regional mechanisms to achieve desired outcomes. In “transform” (2c), the focus is not only on changing land use, but on reorienting the whole system by directly influencing powerful top-down system drivers.
**Appendix 5.1**

The relationships between different drivers and outcomes of land use in the Corn Belt social-ecological system

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate, Topography, and Soils → Land Cover and Hydrology</td>
<td>Basic ecological relationships facilitate and constrain interactions in other aspects of the system. The corn belt has a temperate climate and deep glacial soils that make it one of the most versatile agricultural regions in the world. Based on soil and topographical patterns, different landscape positions are better suited to different agricultural and conservation uses. Global climate change may impact average temperature and precipitation, weather severity, and the regional fit of different cover types in the future in ways that are difficult to predict.</td>
<td>Alley et al. 2003, Schulte et al. 2006</td>
</tr>
<tr>
<td>Policy ↔ Markets ↔ Technology</td>
<td>Federal farm policy in the U.S. is often designed to impact the markets of different kinds of crops. In recent history, a high proportion of federal support for farms has been directed to create price supports for production of commodity row crops such as corn and soybeans. Federal regulations and subsidies can also be instrumental in helping to spur new technologies and markets. Such was the case with corn-based ethanol.</td>
<td>Workshop Data; Keeney and Kemp 2002</td>
</tr>
<tr>
<td>Technology → Hydrology, Land Cover, Infield Care</td>
<td>Agricultural and environmental technologies influence what is possible in terms of land use and care. The region’s hydrologic structures are collectively-managed entities that have been altered over decadal timeframes through changes in technology, policy, institutions, and cultural norms.</td>
<td>Workshop Data; Chapters 2 and 3</td>
</tr>
<tr>
<td>Technology, Markets, and Farm Profitability</td>
<td>Farmers are eager to talk about how changing markets and emerging technologies influence their land use decisions. In order to make a living, farmers often have to make careful decisions that will maximize the profitability of their farms. If new agricultural and conservation practices are to be adopted at broad scales, they must be profitable and fit with current technological and market trends in agriculture.</td>
<td>Chapter 3; McCown 2005</td>
</tr>
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<tr>
<td>Federal Farm Policy</td>
<td>Federal farm policy has been shown to influence farmer decisions in many ways. Commodity and conservation subsidies have had widespread impacts on land use at broad scales. The ways in which policies are funded and implemented at local levels can also play a key role in mediating enforcement of regulations and farmers’ participation in incentive programs. Long term, consistent, and straightforward programs that are compatible with farm practices, priorities, and profitability are more likely to elicit high participation.</td>
<td>Workshop data; Chapters 2, 3, and 4; Keeney and Kemp 2002, McCown 2005</td>
</tr>
<tr>
<td>Markets and Policy</td>
<td>Over the last several decades, declining crop prices and increasing input costs have lowered farmers’ terms of trade leading to the need for operators to farm more land to make a living. While agricultural policies have provided funding to support the agricultural system, most of this money supports large-scale commodity crop farms (e.g., corn and soybeans) and land owners (who may not live in rural areas). This has led to fewer farmers in rural areas, an increase in average farmer age, and a decrease in numbers of young farmers, rural population, and community commerce.</td>
<td>Chapter 2; EWG2006, Keeney and Kemp 2002, Duffy 2006, Tilman et al. 2006</td>
</tr>
<tr>
<td>Rural Demographics</td>
<td>Rural people are concerned about changing rural demographics, including loss of people (and especially young farmers) from the land and decline in community commerce and vitality. Because many farmers are nearing retirement and do not know who will farm their land after them, they are reticent to make major changes in their farming practices.</td>
<td>Chapters 2 and 3; McCown 2005</td>
</tr>
<tr>
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<td>-------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Community Norms and Networks; Farmer Decisions</td>
<td>Farmers do not make decisions based primarily on rational economic decision making, but rather based on a host of factors that operate at several different scales. The interaction between community social norms and networks and regional institutions (e.g., government agencies, non-profit organizations, agricultural and environmental groups) can play a key role in mediating the influence of macro-scale markets, technologies, and policies on farmers’ land-use values and decisions.</td>
<td>Workshop Data; Chapters 2, 3, and 4; Fliegel and Korschning 2001, Rogers 2003, McCown 2005</td>
</tr>
<tr>
<td>Regional Institutions</td>
<td>Underground networks of pipelines drain wetlands to increase cropping efficiency, while channelized streams create more land for crops and remove water from the landscape during wet seasons. However, these alterations in hydrologic structure also increase soil loss and flood severity, and deliver water-bound nutrients like nitrate-nitrogen directly into regional waterways. The amount, position, type, and quality of perennial cover has been shown to impact regional biodiversity, water quality, and other ecosystem services. In order to achieve desirable changes in these factors, practices must be implemented in a coordinated manner across landscapes.</td>
<td>Crumpton 2001, Keeney and Kemp 2002, Schultz et al. 2004, Schulte et al. 2006, Nassauer et al. 2007b, Schulte et al. 2008</td>
</tr>
<tr>
<td>Institutions, Community Norms and Networks, Farmer Decisions</td>
<td>Because 90% of the land in the Corn Belt lies in privately-owned and -operated farms, the form and function of landscape-scale hydrological systems and vegetation patterns hinges upon the collective decisions and careful management of farm owners and operators. However, social norms and the involvement of regional institutions (e.g., agriculture and conservation non-profit organizations, government agencies) in community networks also impact hydrology, land use, and land care at landscape scales.</td>
<td>Workshop Data; Chapters 3 and 4; USDA NASS 2002</td>
</tr>
<tr>
<td>Hydrology, Perennial Cover, &amp; Infield Care</td>
<td>Building soil quality, carbon sequestration, and biodiversity and controlling the loss of water and nutrients from the land, requires attention to the interaction between hydrology, the amount, type, position, and quality of perennial cover in agricultural landscapes. To achieve these outcomes, landscape-scale planning and careful infield management are essential.</td>
<td>Workshop Data; Chapter 4; Crumpton 2001, Schultz et al. 2004, Schulte et al. 2006, Nassauer et al. 2007b</td>
</tr>
</tbody>
</table>
### Regional Institutions

<table>
<thead>
<tr>
<th><strong>Agricultural</strong></th>
<th><strong>Technology, Markets,</strong></th>
<th><strong>Federal Farm Policy</strong></th>
</tr>
</thead>
</table>

Agricultural and conservation interests in the Corn Belt, including policy makers, government agencies, and large non-profit and lobby groups, have an influence on federal farm policy. Our workshop participants indicate that these regional institutions also have the potential to influence the development of new markets and technologies to empower agricultural land uses that can achieve desired outcomes.

**Workshop Data:** Keeney and Kemp 2002

### Perennial Vegetation

| **↓ Carbon Sequestration** | **↓ Climate Change** |

When compared to either corn-based ethanol or soy biodiesel, biofuels made from diverse perennial mixtures have been shown to sequester more carbon, produce greater energy per unit area, and lead to greater reductions in greenhouse gas emissions.

**Tilman et al. 2006**
Appendix 5.1 Literature Cited


CHAPTER 6: GENERAL CONCLUSIONS

Over the course of the last four years, I have engaged in myriad conversation with farmers, rural residents, and leaders in Iowa as we have, together, analyzed the current period of change in regional agricultural land use. The enthusiastic answer of a farmer, who was initially reticent to talk with me, summarized a desire indicated by nearly all of my research participants:

*I think the most important thing is doing just what we’re doing – talking about it. For us to understand where you’re coming from and the job you’re trying to do, and for you to understand what from a practicality standpoint works and doesn’t work. [long pause]… The first thing is to sit down and have a dialogue; without that you’re never going to accomplish anything.*

Once I had developed rapport and a measure of trust with my interview subjects, almost all were eager to discuss the transition that is currently occurring in Corn Belt systems. The discussions of which I was a part were pervaded by a persistent tension. Pressure is mounting on agricultural landscapes to deliver multiple societal services—including food and energy production and provision of ecosystem services—at the same time that quality of life and community vitality in rural systems is being put on life support. While my research participants had different perspectives on the causes and potential ways of dealing with this tension (and I learned a lifetime’s worth of lessons from them), several consistent findings, which I summarize here, emerged from the results of my research.

I initiated interviews because we were eager to learn how restoration of perennial vegetation could be achieved in rural, privately-held landscapes given existing social norms and perceptions of place. At the spatial scale where we saw landscapes and watersheds, the rural people we interviewed saw farms and communities. While interviewees generally responded positively to pictures of conservation practices that restored perennial cover types on marginal agricultural land, implementation of such practices is currently neither a priority nor well integrated into rural experience and values. Like biophysical landscapes and watersheds, community scale social norms and networks span private property boundaries
and may be instrumental in bridging gaps between individual values, societal goods, ecosystem services, and collective institutions.

Rural stakeholders and regional leaders emphasized that social-ecological systems are currently trapped in a static configuration by the convergence of factors operating at several scales. These factors make system-level change—including the increase of perennial cover on the landscape—difficult. However, the emerging bio-economy ushers in a time of reorganization and uncertainty, creating potential for long term change in key system structures. The successful adoption of perennial conservation practices depends upon adaptation of socio-cultural and political structures at three scales within Corn Belt systems: field-individual, landscape-community, and regional-institutional scales. Initiatives that focus on optimization of outcomes at only one scale are not likely to result in widespread adoption or in long term and lasting change.

Limiting factors in this system are highly social in nature and include cultural, as well as spatial and temporal, components. In particular, “community” arose repeatedly in my data as important in mediating the interactions between individual decisions on private properties and regional outcomes encouraged by institutions. My research suggests that an increase in interpersonal contact between conservation agents and potential adopters of conservation practices may play a key role in brokering information across scales and in bridging differences in regional versus local perceptions. Such collaborative learning has the potential to harness the adaptive capacity of regional social actors to bolster the ecological resilience of Corn Belt agricultural systems.

Regional leaders offered insight into how policy mechanisms might enable the incorporation of perennial conservation strategies into the agricultural lexicon. To address the complexity inherent in initiatives that span private property boundaries, policy mechanisms must build partnerships that blur distinctions between working lands and protected areas. Initiatives must also bridge gaps between local creativity and initiative and regional support and accountability. Examples of mechanisms to achieve these outcomes include competitive watershed improvement grants for multi-level partners, landscape planning efforts that incorporate the perspectives of diverse stakeholders, and the strengthening of markets for agricultural land uses that also bolster ecosystem services and
societal goods (e.g., carbon sequestration, biofuel production from perennial biomass, rural aesthetics and recreation, and wildlife viewing and hunting). Success of each of these mechanisms was seen as dependent upon creation of vertical and horizontal forms of social capital that facilitate strategic collaboration within and between social actors operating at different levels of the system. In the Corn Belt, much of the adaptive capacity to bolster ecosystem services and societal goods lies in this relational capital.

The future scenarios presented in Chapter 4 provide a vision of how regional actors might adapt or transform the current way of doing agriculture in the Corn Belt to achieve desired multi-objective outcomes, including the provision of ecosystem services and societal goods. These scenarios demonstrate that, if top-down factors such as markets, technologies, and federal farm policy are allowed to be the overriding drivers of farm owner and operator decision making, Corn Belt landscapes will become highly efficient at rowcrop production at the cost of ecosystem services and other societal goods. The scenarios further demonstrate that these other outcomes will only come about if mechanisms to understand and bolster multifunctionality are directly constructed as central components of Corn Belt systems. Although the future is uncertain, the perspectives of regional scientists, stakeholders, and leaders suggest that adaptive or transformative landscape change to achieve desirable multi-objective outcomes is possible if a coordinated strategy of change is implemented across multiple levels of the system.
APPENDIX A: INTERVIEW PROTOCOLS

[Text in italics and brackets represents unspoken instructions to interviewer]

A. Introduction:

Hi, I’m Ryan Atwell. I’m a graduate student in the College of Agricultural at Iowa State University. Like I told you on the phone, I work the Department of Natural Resource Ecology and Management to help design and implement conservation practices like stream buffers and wetlands on the landscape. We are getting better at engineering and placing these practices to improve water quality and wildlife habitat. But the biggest challenge of my work is to figure out how to implement these practices consistently on a working landscape owned and operated by many, many different people. We call this “landscape ecology,” thinking about how people, water, and wildlife interact with the landscapes on which they live and work. I chose to talk to people around Stanhope because it is far enough away from Ames that it is out of our bubble and is a true rural community that is tied to the agricultural landscape.

It is really important for me and the people I work with to get the perspective of farmers and rural residents in the work that we do. I grew up spending a lot of time helping out on my grandparents’ Illinois farm, and from an early age fell in love with wildlife and conservation work. In my education, I’m trying to learn more how these two worlds, the farming and the conservation, can fit together. I want to make sure that the views of rural Iowans’ are represented to policy makers, researchers at Iowa State University, local community leaders, and environmental land managers who work for agencies like the NRCS. I also hope that you will benefit from this opportunity to explore and share your connections to your community and your land.

Here is how I would like to use the next hour. First, I’m going to ask you a few questions to learn what you like and value about the countryside around Stanhope. Then I want to get your feedback on several pictures that show different practices that might be implemented across the Iowa landscape in the future. To close, I’d like to get your ideas about how we can make the landscapes that we prefer a reality. In all instances, please consider what is best for the state of Iowa, for your local community, and especially what you would want in your own backyard. There are no “right” answers. It is most helpful if you tell me exactly what you think.

I’m going to record what you are telling me on this paper so that we can both refer back to what has been said. Everything you say will be kept confidential, unless you wish it to be otherwise. If it is OK with you, I’d like to record this interview so I can refer back to what you said. The information that you provide us will not be used in a way that reveals your identity without your consent. You can choose to terminate this interview or have us remove the information you provide from our study at any time. Do you have any questions about the confidentiality of this interview? Is it OK with you if I record this interview? [Turn on recorder. If anyone refuses, conduct the interview without the recorder]
B. What do you value?
[list key places, people, characteristics and concepts provided by interviewees on left side of
drawing paper under header “brainstorm.” Try and hit on all the topics in these questions,
but do not necessarily ask all the questions or in this order. Place priority on the subjects
that are of most interest to the interviewee. Try not to spend more than 20 min. on this
section. ]

1) What first comes to mind when you think of the Iowa countryside?  [If needed, follow up
with…] What places, people, characteristics or attributes do you most value about Stanhope
and the surrounding landscape? [list these with a brown marker].

2) What changes are taking place in Stanhope and its countryside [list/underline these with a
rose marker]? 

3) What are the problems facing your community or and its landscape [list/underline these
with a red marker]? 

4) What are some of the economic resources of Stanhope and its countryside [list/underline
these with a purple marker]? 

5) [list/underline these with a dark green marker]
   a. What do you appreciate specifically about physical features around Stanhope, its
      land, its natural resources, its environment? 
   b. When you think about the beauty of the countryside, what comes to mind? 
   c. Do you have concerns about the natural resources or environment in your
      community and landscape? [also mark these with a red marker] 

6) I’m interested specifically in what relationships, aspects of community, or civic resources
   you value in this community and its countryside? [list/underline these with a blue marker]

7) Which of the things we have listed do you most value about Stanhope and its surrounding
countryside [put a gold star by these]?
C. Exploring Futures with Perennial Vegetation through Pictures:

1) I have a bunch of pictures that I would like you to sort into 5 piles, and then we’ll take closer look at each picture and why you put each where you did.

- Pile 1 – What is best for Iowa, your local community, and what you would want in your backyard, or what you would want to farm.
- Pile 2 - Next best
- Pile 3 – Neutral / Undecided
- Pile 4 - What is worse for Iowa, your local community, what you would not want in your backyard, or what you would not want to farm.
- Pile 5 – Worst

If you want, you can ask me questions about the pictures while you are sorting them.

[Record pile # for each of each of the photos.]

Pictures:
- **Buffer 1**: riparian buffer on Bear Creek with young trees/shrubs and curvy edges
- **Buffer 2**: riparian buffer on Bear Creek with mature trees and straight edges
- **Confinement**: animal confinement system
- **Corn**: contoured row crop corn landscape
- **Intercropping**: strip intercropping including perennial cover.
- **Pheasant**: Pheasants Forever stream buffer habitat project
- **Prairie**: restored prairie
- **Rotational**: flash grazing of set aside land
- **Soybeans**: straight soybean rows leading to well-kept farmstead
- **Suburban**: new housing subdivision on former farmland
- **Switchgrass**: perennial switchgrass for ethanol/bioenergy.
- **Trail**: buffer with public access trail
- **Wetland**: restored wetland at base of tile line in Conservation Reserve Enhancement Program
- **Wind**: wind farm.

2) Tell me why you placed the pictures that you did in each pile. [compare and contrast picture placement among piles]

[Add reactions to mental map]

3) [As we look over pictures and converse about them, the following are some of the questions that might be asked for each picture.] What did you first notice in this photograph? What else do you notice? In this photo, what would you describe as attractive? Why? What would you describe as unattractive? Why? For a farmer, do you see any advantages or disadvantages to the landscape and practices that you see in this picture? What would you change about the landscape in this picture?

4) After having talked about these different photos, would you want to change your placement of any of them?
E. Making Preferred Landscapes Into Reality

[on a clean sheet, begin a concept diagram]

Now I would like to explore how we can make beneficial changes in rural communities and the countryside happen. Let’s review some of the main points you’ve told me [go back lists and review main points, begin to make a concept diagram representing ties between main points].

1) Are there other concepts that are important to rural community or countryside that you would like me to add to the chart? [add these to the chart in their original color]

2) How do these concepts that are on this diagram relate to one another? [use black marker to represent relationships]

3) What needs to change to make these concepts a reality? [draw these features with a rose marker]?

4) What external assets or resources might be necessary? [draw these features in purple]?

5) What assets and resources of Stanhope and its farms and countryside could be used to implement these alternative futures? [draw these features in blue]?

6) What would you do to implement these changes in your community? [draw these features in red]

7) What would it take for you to implement habitat improvements on your farm, on your land, or in your community? [draw these features in orange]

F) Trust and Cooperation?

1) Where do you get help or assistance when managing the resources on your farm?
   a. local co-op, elevator, agribusiness agronomist
   b. farm organizations like farm bureau, corn growers, soybean association
   c. farm journals / internet
   d. government agencies like the NRCS, DNR, and National Wildlife Refuge System
   e. your county conservation board
   f. Iowa State University Extension
   g. scientific research
   h. your church or local churches
   i. your bank
   j. other farmers

2) Specifically, where do you get information about promoting wildlife and biodiversity on your farm?
G) Wrap up

Well, that is all I have. Are there any additional comments you would like to leave me with?

Is there anyone else in your community with whom I should speak about the issues we have been discussing?

Before I leave, can I get a little information about your background (and farm). [Give interviewee background information form, or fill it out yourself.]

Great! My contact information as well as that of my supervisor is on this letter. Please feel free to contact me with further questions or comments, or if you know of someone else who is interested in this study.

Thank you so much for your time!
Intercropping

Pheasant
APPENDIX C: INTERVIEW NODE TREE

Note: the following node tree is a list of codes that were used to categorize and manage interview data in preparation for further qualitative analysis.

Aesthetics
   Beautiful
   Fresh Air / Outdoors
   Green
   Peaceful / Quiet
   Open Spaces
   Solitude
   Straight and Curvy Lines
   Unpleasant

Complex Issues
   Hog Confinements
   Role of Science
   Globalization
   Energy
      Ethanol
   Agricultural Technology
   Bioeconomy
   Agribusiness / Corporate Farming

Countryside
   Peopleshed

Diffusion of Innovations
   Compatibility
   Complexity
   Ephemeral
   Familiarity
   Farm Info?

Ecology / Natural Resources
   Animals
      Domestic Animals
      Wildlife
         Birds
         Deer
         Predators
   Land Use Types
      Annual Row Crops
      Perennial
         Buffer
CRP
Fence Row
Hay
Intercropping
Native Species
Pasture
Prairie
Switchgrass
Trees / Timber
Wetland
Wildflowers

Sprawl

Recreation
Access
Hunting
Trail
Water Bodies
Lake
River
Boone
Stream
Dredge Ditch
Squaw Creek

Economics
Big Business
Farming Not Easy
Is It Worth It?

Emotions
Comfort
Excitement
Frustration
Hope
Mourning
Trust / Suspicion

Ethics/ Perspectives / Social Norms
Belief
Careful
Clean / Neat
Do the Right Thing
Don’t Want to Mess
Environmental / Conservation
Best Land Worked, Marginal Land Buffered
Conservation Not Needed Here
Conservation Valued Elsewhere
Conservation Valued Here
Restoration
Soil Stewardship
Water quality
Future generations
Independence
  Own Boss
  Private Property
  Regulation
Planting Seed and Watching It Grow
Production
Solidarity with Farmers
Work

Future Scenarios

Government Programs
  Commodity
  Green
  Target

People / Relationships / Communication
  Academicians / Scientists
  Childhood
  Church
  Cross-Boundary
  Face to Face
  Family
  Large Operators
  Local Support Structures
    Aides
    Conservation Personnel
  Neighbors
  Non-farm rural residents
  Old Farmers
  Opinion Leaders
  Outsiders
  Owner / Operator
  People on Land / Farm
  Young Farmers
Pictures
  Buffer
  Confinement
  Corn
  Housing
  Intercropping
  Pheasant
  Prairie
  Rotational
  Soybeans
  Switchgrass
  Trail
  Wetland
  Wind

Places
  Ames
  Iowa
  Iowa State University
  Other Places of Meaning
  Stanhope

Practices

Quotes

Recurring Stories
  Funeral
  Snow plowing
  Help with harvest

Scales
  Biophysical
    Farm / Infield
    Landscape
    Regional
  Social
    Community
    Individual / Household
    Institutional
    Organizational
APPENDIX D: WORKSHOP PROTOCOLS

Objectives:

Objective 1: Briefly share scientists’ and rural residents’ answers to the “what, where, and how much” of perennial conservation practices to regional leaders in agriculture, environment, and policy.

Objective 2: Identify key policy and institutional leverage points—including roadblocks and opportunities—to promote perennial vegetation and system resilience across scales in the rural Corn Belt.

Objective 3: Brainstorm ideal future goals related to restoration of perennial vegetation and creative alternatives strategies to realize these goals.

Materials:

- Video recorder
- 2 digital audio recorders
- 2 microphones
- Projector
- Markers and Crayons (Dry Erase?)
- **Flip charts with categories?**
- **Extra pens and pencils**
- Name tents
- Maps for walls:
  1. Upper Mississippi River Basin
  2. Iowa conservation practices
  3. Land cover of our study site
  4. Helmers’ farm aerial
  5. Helmers’ farm land cover
  6. Joan Nassauer current landscape
  7. Joan Nassauer biodiversity scenario
- Poster with five scenario considerations:
  1. Ethanol production
  2. Energy and Carbon
  3. Water quality
  4. Biodiversity
  5. People on land
- Packet for participants
  1. Workshop agenda
  2. Workshop information sheet that was sent out ahead of time
  3. Response questions
  4. Diagrams from interviews
  5. Maps that are on the walls?
  6. Informed Consent Document
  7. Copy of Informed Consent Document
Lunch (12:15-12:45 P.M.)
Participants can arrive early. People get food as they come in, and can sit down and talk to us and each other; this allows some break the ice activity as everyone is showing up. People continue to eat as we proceed.

Introduction (12:45-1:05 P.M.)

[We will hand out a packet to each participant—see materials]

A. Why we brought you here: All right, you all can keep eating, but we are going to get started here. As was briefly explained in this one-page summary that I sent all of you by email, Lisa, Lynne, Drake, and I are part of a large interdisciplinary team of scientists at Iowa State University and other partner institutions who are looking at ways that strategic, well-targeted restoration of perennial vegetation to agricultural landscapes in the Corn Belt can help us achieve agronomic and environmental goals. By “restoration of perennial vegetation” we are referring both to practices on marginal agricultural land such as wetlands and stream buffers, as well as practices on some productive farm ground in the form of more diverse cropping rotations, winter cover crops, or perennial biomass grown to produce ethanol. We are confident that such restoration is one important component to maintaining regional ecological integrity and addressing the issue of hypoxia in the Gulf of Mexico. The face of regional agriculture is undergoing a period of rapid change as a result of the emerging bioeconomy. As we enter this period of unprecedented opportunity and challenge in regional agriculture and conservation, it is essential for us to work to understand the changing social, economic, and political contexts in which conservation occurs. There may also be roadblocks or opportunities out there that we are not aware of. Understanding what may or may not be culturally, politically, and socially feasible in the decades to come helps us better decide and prioritize our research agenda. That is where we need your feedback and input.

B. Overview of day
   i. Here is how we would like this afternoon to go:
      1. In a minute, I’m going to go over some guidelines for our discussion.
      2. Then we’ll briefly go around the room and introduce ourselves.
      3. After that I will give a 15 minute presentation summarizing the background of our research and the results of my interviews with farmers and rural residents.
      4. There will be time for you to ask questions about interviews.
5. Then we want to get into a deeper discussion about what is and is not working well in terms of farm conservation policy to influence water quality and biodiversity in the Upper Mississippi River Basin, and especially Iowa. We are going to focus on roadblocks and opportunities given the emerging bioeconomy.

6. We will build on this by talking about possible future scenarios.

7. And we will close by going around the room and giving each of you with a chance to provide us with a few final comments.

C. Ground rules

i. First off, we are video and audio recording this meeting so that we can accurately summarize and analyze what was said today. In order for us to do this, we must first obtain your written consent. If you look at the second page in the packet we just passed out, you will see an informed consent document. I’m going to read that aloud:

The proceedings of this workshop are being recorded in audio and video formats so that we can accurately summarize and analyze what was said today. Recording allows us to participate in and focus more fully on your discussion, and eliminates the need for us to capture all of your ideas on paper immediately. None of the information from this workshop will be reported in such a way that individual identities are revealed without your further consent at some future date. Actual recordings will remain confidential and will only be viewed by the members of our research team listed above.

If you have any concerns or questions about our use of recording equipment, please voice them now. If you become uncomfortable with your comments being recorded, please raise them with one of us. If possible, we will temporarily suspend recording. Of course, you may also choose to remain quiet or leave the room at any time.

By signing below, you authorize us to record your comments in this workshop in audio and video formats for the research purposes described above.

Are there any questions or concerns about the use of recording equipment today? [Answer Questions]. Alright, if you could sign that document, and pass them …

ii. The issues that we want to discuss are not highly controversial, but will likely involve differences in opinion. That means we want to hear from everybody. It also means that there are no right answers. We brought you together to question our assumptions as well as those of your peers. We welcome the creativity that can arise when groups of people share opinions with one another and bounce ideas back and forth. Please be
frank with us and listen respectfully to each others’ viewpoints. We encourage you to talk about the discussions we will have today after you leave, but ask that you use discretion when you associate individuals here today with different opinions and viewpoints so we can all feel more free to talk openly.

iii. The intent of this discussion is to elicit ideas, not to come to a consensus or agree. If, through this workshop, we are able to better understand differences in perspectives, that is a really helpful thing.

iv. We have several questions for you, and we hope that the discussion here today will be a back and forth give and take. You don’t have to raise your hand to speak. Again, we hope to hear from everyone at the table, so try not to dominate the conversation, but don’t be shy either. Part of our job is to encourage quiet people to speak up and to ask those who are saying a lot to defer at times to others.

v. We intentionally brought together a diverse group; the breadth of knowledge around this table is impressive. But our different backgrounds may also mean that certain members of the group may use jargon or “shop talk” that the rest of the group may not be familiar with. We will do our best to avoid the use of scientific and theoretical terminology, but if certain phrases or concepts that we, or others in the room, use are unclear, please do not hesitate to interrupt and ask for clarification. We’re going with the “there are no stupid questions” approach today.

vi. Please feel free to get up to get more food or coffee or go to the bathroom whenever you like.

D. Introductions (quick go around, so people know each other)

i. Name

ii. Briefly! describe 2-3 hats you wear related to ag. and envir. that are most relevant to the discussion today. [Lisa, Lynne, and I can start and demonstrate short and sweet responses.]

Individual Brainstorm (1:05-1:15 P.M.)

If you look at the next piece of paper in the packet that we gave you, you will see a page with four questions. Before we present data from our interviews with farmers, we would like you to take about ten minutes to jot down some answers to these questions based on your own experience.

Questions on worksheet:

4) Based on your experience, consider what policies, practices, and programs are working particularly well right now in the Corn Belt to bolster:

   a. water quality (including reduction in nutrient export)?

   b. wildlife and biodiversity?
c. rural communities?

5) Corn Belt landscapes will change a great deal in the next decade in response to the emerging bioeconomy. What do you see as some of the key opportunities for:
   a. surface water quality (including reduction in nutrient export)?
   b. wildlife and biodiversity?
   c. rural communities?

6) What are the greatest roadblocks that may hinder:
   a. surface water quality (including reduction in nutrient export)?
   b. wildlife and biodiversity?
   c. rural communities?

Presentation of Farmer Interview Data (1:15-1:45 P.M.)

Ryan introduces perennials as an adaptive strategy as well as brief results of farmer interviews.

(5-10 min break; either here or after the group brainstorm)

Group Brainstorm (1:50-2:30 P.M.)

Alright, for the next fifty minutes or so, we are going to have an open discussion about the questions we asked you to consider before our presentation. We’re going to record on these flip charts some of the general points of what is shared in terms of working well, opportunities and roadblocks related to conservation in Corn Belt agricultural watersheds. We will also record ideas at the different biophysical and social scales referred to in interviews: infield/household; landscape/watershed; and region/institution.

[Facilitated discussion with brief talking points being recorded on flip pads. Make sure to bring out all voices. Push people to consider both positives and negatives as well as multiple scales. Make sure we write only brief answers on flip charts, not letting white boards become the center of attention and slow down the discussion. The chart below provides a framework for discussion topics to hit on.]

<table>
<thead>
<tr>
<th>Working Well</th>
<th>Infield/Farm</th>
<th>Landscape/Community</th>
<th>Regional/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunities</td>
<td>X</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>Roadblocks</td>
<td>X</td>
<td>X</td>
<td>x</td>
</tr>
</tbody>
</table>

Simple points from resilience theory to consider and follow up on during conversation:

1) **Symbols and Scales.** What do our different participants see as the symbols or metaphors organizing their thinking about the current system? What do they see as the key drivers or roadblocks in the system? What language do they use to describe the system? At what scales do these processes exhibit themselves? What scales are our participants interested in or missing? Do their comments focus one or another scale? Are these
scales primarily social or biophysical? Noting omissions in the conversation would be important data to document, but we also want to get participants to address multiple scales.

a) Questions
   i) We’ve been talking a lot about policy. But how does policy actually reach farmers and rural people? What do we want the land to look like?
   ii) If that’s what we want the landscape to look like, how do we get farmers to implement these practices?
   iii) How do we get information to farm owners and operators?
   iv) How do we get payments to the farm owner or operator responsible for implementing a conservation practice?
   v) We’ve talked about targeting biophysical landscapes. What about the social dimension of farming? How do we reach certain farmers who we hope will change practices on key portions of the landscape.

b) Comments to look for and follow up on:
   i) Allusions, stories, metaphors, terminology
   ii) All or nothing statements
      (1) Well, our whole problem is .
      (2) We are never going to see that happen unless .
      (3) Well, it’s all about .
   iii) Focal statements
      (1) One key is .

2) **Optimization vs. Complexity.** Is their tendency to optimize one or a few variables such as production or profit or N levels rather than look at the whole system? Or vice versa? What are the key areas of focus for different people at the table? When or how does the complexity become overwhelming?

a) Questions:
   i) So it sounds as though when it comes down to it, you see as the bottom line?
   ii) We’ve established that this is a big problem, but how do we start to address it?
   iii) Well, that would help X, but what about Y?

b) Comments to look for:
   i) Well, really it’s not that simple…
   ii) You also have to consider .
   iii) All or nothing statements
      (1) Well, our whole problem is .
      (2) We are never going to see that happen unless .
      (3) Well, it’s all about .
   iv) Focal statements
      (1) One key is .

3) **Change, adaptation, and innovation.** Resilience theory is all about change through collapse, reorganization, and renewal. But people often resist change. How do our participants talk about change? Do they see change (including times of disorganization and collapse) as a natural part of the system? What changes are participants open to, and
what changes are seen as a threat? Why? Is adaptation and ingenuity more geared towards maintaining the present system configuration?

a) Questions:
   i) Where is the system changing now?
   ii) Do you think that can change? Why or why not?
   iii) Can we change that?
   iv) What would it take for that to change?
   v) Are there any alternatives to?

b) Comments to look for:
   i) Comments playing off short term vs. long term challenges and benefits.
   ii) Comments trying something new or throwing something out there for consideration:
      (1) Well, what if
      (2) Hmmm, maybe we need to look at this a whole different way.

4) Power. What are the unspoken, but real, political or cultural barriers to perennial vegetation? Where does power reside in the Corn Belt system. What recognized or unrecognized political or power barriers, alliances, social or political norms, currently hinder the achievement conservation goals and resilience in Iowa? What recognized or unrecognized political or power barriers, alliances, social or political norms can help us reach desired future scenarios and build resilience to change into the system?

   “Simplifying (or uncomplicating) the relationship between organization (bureaucratic and political) and community affords greater resilience, but is far subtler than declaring processes “open and participatory” (From Panarchy [Gunderson and Holling 2002]).

a) Questions
   i) Whose responsibility is that?
   ii) Who has the power to change that?
   iii) What would X think about that?
   iv) That sounds great, but what has to happen if it is really going to become a reality? Really?
   v) But is that really enough to do the trick? What about ?

b) Comments
   i) Anything having to do with imbalances or opportunities to link institutions and communities.
   ii) Any comments given in confidence such as, “well, we all know that one of the unspoken problems here is…”
   iii) Talk about relationships—between individuals, interest groups, or institutions.
   iv) Talk about justice—environmental or social.

Scenario Development (2:30-3:35 P.M.)

We have spent the last hour talking about what is happening in Corn Belt agricultural systems. Now we want to talk about what may be possible in the future and how policy can get us there. The point of this exercise is not at all to hammer out the details of any actual policy today. Rather, we would like to harness the substantial experience and creativity in this room to think outside the box, talk about what the future might look like, and how policy can get us there. We encourage you to be creative and think outside the box here.
Over the course of this discussion, we encourage you to consider policy “scenarios” that maximize one or more of the following through changes in agricultural landscapes. While these categories may not be mutually exclusive, let’s take them one at a time to begin with and then look for synergies.

1. Energy Independence
2. Carbon Sequestration
3. Water quality
4. Biodiversity
5. Thriving Rural Communities

[Use the below as we have time and need]

Before we start, I want to share some examples of scenarios to get your juices flowing.

In the final phase of interviews, we also asked farmers to share their ideal, creative ideas of what future landscapes might look like. Here are what a few of them said:

One 54 year old farmer who operated 760 acres of corn and soybeans and ran a turkey operation that sold about 36,000 head a year said:

“Ideally, I’d like to see the land stay in local hands. I’d like to see everyone who wanted to be farm be able to afford to own some land themselves, rather than have to depend on renting from especially out-of-state landlords who don’t necessarily understand land. I’d like to see… Now, you’re talking, be totally idealistic here? Not realistic at all? I’d like to see things be on a smaller scale and more diversified again, so there could be more people here and maybe some more small businesses in town.”

Another farmer who farmed about 4000 acres of 60/40 corn and beans, farrowed 7000 pigs a year and finished 34,000 head, said:

“Number one, keep the farm families on the land. Number two, the technology that is coming is not gonna get any smaller, it’s just gonna keep booming, [pause] and I think that’s a positive. [pause] And the environmental side of it is not gonna go away. So, that’s something that we’re going to have to continue to work with and continue to get better at… You could draw arrows between these three and just make it a big circle, because the technology is going to help on the environmental side. The environmental side—the farm families want to keep the environment protected as much as they can because they’re out here, living in that area. And in order for the farm families to stay out here, they’re gonna have to utilize the technology.

Finally, a rural resident who had grown up on farms and was now a contractor, and also an avid outdoorsman and hunter said:

“I’m not using the right terminology, but I sort of feel like we’ve reached a point of [pause] oh, if the right word is critical mass or whatever it is, in terms of agriculture, and we really got to stop it. I don’t expect it to go back the way it was 50 years ago, but [pause] quality of water, from drinking to fishing to looking at it. Um, you know.
It’s time to focus... that subsidy thing is the root of the evil here. That’s my opinion... everyone’s complaining about [rural communities] dying. Hey we’re just gonna continue dying. That’s my thought. We don’t... we are never going to have the people here. We are never going to have the people here! Just … I think people are willing to pay more taxes if the quality of life is there. I’m one of them.”

Here is a picture of a future landscape “scenario” developed by an Iowa native and ISU alumni in Landscape Architecture named Joan Nassauer. This picture here is a photo of the actual landscape taken from plane in 199X. Joan digitally modified this photo to reflect a scenario developed by a team of scientists from several disciplines to maximize water quality, biodiversity, and agronomic production.

Some of the farmers Joan talked to really liked this scenario because it mixes high production agriculture with large tracts of habitat interspersed throughout the agricultural mosaic. They thought this landscape looked pleasant, progressive, and futuristic. Other farmers that we talked to did not like this scenario because they thought that strip intercropping was a real hassle given current production techniques. This scenario is not perfect, but it is one way to consider what the landscape might look like in the future. It gets us to think about the landscape in a different way.

We have several posters hanging around the room that we can reference in our discussion and draw on insofar as it is helpful to illustrate ideas. This one shows relative nitrate export from the watersheds that make up the Upper Mississippi River Basin. This map put together by a graduate student named Carrie Wiltshire shows conservation practices in Iowa. Here is a map showing land cover of the watersheds and small towns that comprise our study site. This is an aerial photo, and this is a map of cover types for a Des Moines Lobe farm that belongs to the Helmers Family. Matt Helmers is a professor in Ag and Biosystems Engineering at ISU who is part of the perennial team. And we can also draw on these aerial photos developed by Joan Nassauer.

[These posters are hung around the room with multiple copies so that we can draw on them if needed]

**Closing Comments (3:35-4:00 P.M.)**

Alright, we have about twenty five minutes left. At this point we want to pause and give everyone a minute to think about any final comments or scenario ideas that they might want to share with the group. Then we will go around and give everyone a last change to speak their mind [Pause for about thirty seconds]. Alright, try and keep your closing comments to a couple of minutes so those who need to leave can hear from everyone. Let’s start with…

[go around the table, starting with an end that has someone who has spoken up but not dominated]
APPENDIX E: WORKSHOP NODE TREE

Note: the following node tree is a list of codes that were used to categorize and manage interview data in preparation for further qualitative analysis.

Analysis
   Focal Statements / Notable Quotations
   Negative Evidence

Bioeconomy
   Biocarbon Products
   Biodiesel
   Carbon Sequestration
   Ethanol
      Cellulosic
   Wind

Characteristics / Strategies
   Bridging
   Critical Mass / Thresholds (also theory)
Economics
   Alternative Markets
   Competition
   Externalities
   Funding
      Block Grant
   Income
   Less Costly
   Markets as Stimulus
   Price-control
Education (Technical Assistance)
Ends and Means
Freedom / Options / Flexible
Incentives
Leadership (also Theory, aka Opinion Leaders)
Local Control / Stake
Partnerships
Performance-Based
Planning
Policy Barriers
Reciprocity
Regulations
Responsive
Science
   Information / Knowledge
   Monitoring
Simple / Tell Me What I Need to Know
Systems
Trying Things Out
Target
Value / Motivation
Vision / Creativity

Emotions
Challenge / Reticence / Suspicion
Positive Response / Enthusiasm
Strongly Voiced
Synergy

Evaluations
Future Scenario
Leverage Points / Opportunities
Needed
Roadblocks / Challenges / Currently Lacking
Sacred Cows
Working Well

Natural Resources
Aesthetics
Biodiversity
Wildlife
Land / Cover Types
Forest
Marginal
Riparian
Wetlands
Algae
At Base of Tile Line

Working
Biomass Crops
Monoculture
Diverse Prairie Mix
Cover Crops
Pasture / Cow-Calf
Row Crop

Recreation
Soil
Water
Quality
Nitrate Export
Watershed
Players

Academia
  ISU
    Extension
    Research

Conservation Personnel / Land Managers

Private
  Farm Operators
  Farm Owners
    Absentee

NGO
  Cattlemen
  Corn Growers
  Iowa Farm Bureau
  Iowa Natural Heritage Foundation
  Iowa Soybean Association
  The Nature Conservancy

Rural Communities
  Conservation Districts
  Drainage Districts

Public
  Counties
  Federal
    Natural Resources Conservation Service
  State
    Iowa Department of Natural Resources
    Iowa Department of Agriculture and Land Stewardship

Programs
  Conservation Reserve Program
  Conservation Reserve Enhancement Program
  EQIP
  WHIP

Scales
  Farm / Infield / Individual / Household
  Landscape / Community
  Regional / Institutional

Theory (Resilience and Diffusions of Innovations)
  Adaptation / Innovation
Adoption
Change
Compatible
Complexity / Unintended Consequences / Uncertainty
Disorganization / Collapse
Drivers
Ephemeral
Familiarity
Growth
Optimization / Efficiency
Path Dependency
Power
Renewal
Social Capital
  Autonomy
    Integrity
    Linkage
  Embeddedness
    Integration
    Synergy
Static Trap
Symbols